FAUNA HAWAIIENSIS

VOL. I. PART IV.

VERTEBRATA

R. C. L. PERKINS

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VERTEBRATA

By R. C. L. PERKINS

FAUNA HAWAIIENSIS

OR THE

ZOOLOGY OF THE SANDWICH (HAWAIIAN) ISLES:

Being Results of the Explorations instituted by the Joint Committee appointed by

THE ROYAL SOCIETY OF LONDON FOR PROMOTING NATURAL KNOWLEDGE

AND THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

And carried on with the assistance of those Bodies and of the Trustees of

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EDITED BY

DAVID SHARP, M.B., M.A., F.R.S.

SECRETARY OF THE COMMITTEE.

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VERTEBRATA.

By R. C. L. PERKINS.

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VERTEBRATA[1].

By R. C. L. Perkins.

REPTILIA[2].

THE reptiles here enumerated are but seven in number, namely four geckos and three skinks. In addition to these several species of frogs and toads have been recently imported into the islands from Japan and America for economic reasons. These are naturally of no importance or interest in connection with the Hawaiian fauna and consequently are not included in the list. It is open to doubt whether some of the geckos and skinks may not also have been imported in ships since the occupation by white men, but it is certain that at least one of each of these groups was present before the discovery by Cook. The native name for all the species is Moo. All the known species have been fully dealt with by Dr Leonhard Stejneger in his paper on the "Land Reptiles of the Hawaiian Islands[3]," to which the reader is referred for descriptions of the species. In striking contrast with the birds, the lizards all appear to be widely if not universally distributed over the islands, and all have a wide distribution in the islands of the S. Pacific. All of the geckos commonly, and two of the skinks on some occasions, are to be seen within houses. The former are entirely nocturnal, coming out at dusk and running over the walls and windows of houses, and may also be seen hunting for food on the trunks and amongst the foliage of trees. In the day-time they hide under boards or stones, loose bark, in holes in tree trunks, behind pictures in houses, or in dark corners. Their food consists to a great extent of ants, especially of that detestable species *Pheidole megacephala*, but many other insects are devoured. Their partiality for entering houses is no doubt largely due to the fact that they there find abundant food, in the shape of insects, which are attracted by the light, as well as convenient hiding-places in the day-time. Even large insects are sometimes eaten, for on more than one occasion I observed a fox gecko catch and devour a mature female of a Locustid (*Xiphidium fuscum*). This insect, as large as a moderate-sized grasshopper, was swallowed whole, head first. The eggs of the geckos are usually placed in holes in tree-trunks or in cracks in woodwork,

[1] The Committee has not attempted to deal with the marine Fauna. The fishes found off the Hawaiian islands do not, therefore, come within the scope of this work. EDITOR.

[2] Arranged in accordance with the views of Mr G. A. Boulenger. EDITOR.

[3] Proceedings of the United States National Museum, Vol. XXI. pp. 783—813.

but are also sometimes attached to the leaves of plants in great numbers, often several in a bunch. As a rule the various species keep apart from one another when resting in the day-time. Thus under the bark of a single tree more than one hundred specimens of *Lepidodactylus lugubris* were observed, but no other species. Two groups of banana plants only a few yards apart were tenanted by different species, one of them producing the above-named species in numbers, while on the other were several examples of *L. crepuscularis*. After these latter were removed, in a day or two both of the banana patches were occupied by the former. *L. crepuscularis* is probably much less numerous than either of the other three species.

Of the skinks two (*Lygos cyanura* and *Ablepharus boutonii*) are diurnal and delight in the hottest sunshine. The former may be seen in thousands on old walls built of lava, and on black lava-flows, and the latter is also very numerous both on the lava rocks and on the trunks of large forest trees. The third species (*Lygosoma noctua*) I used to observe in Honolulu, catching the insects attracted by the electric light above the doorway of a house. Here quite a little colony had established itself, but after a time a large grey rat took up its position on the ledge above the door, feeding on the moths, which it caught between its front paws, and either it devoured the lizards also or at least they disappeared.

The eggs of the skinks are to be found in numbers in the cavities of porous blocks of lava, in holes in tree trunks and beneath the bark.

Possibly one or two of the existing Hawaiian species have been imported by man into the islands, but there is no doubt that most are to be considered as natural immigrants. The eggs and even some of the lizards themselves might easily be carried enormous distances with floating timber; quite as easily in fact as many of the indigenous insects, the ancestors of which can only have arrived by these means. It seems to me more than probable that the fact that they present little or no specific differences from outside forms is most probably due to the fact that belonging to common and widely spread species fresh individuals reach the islands by natural means, and the island-examples are not isolated for any great period of time.

Fam. GECCONIDAE.

HEMIDACTYLUS Gray.

(1) *Hemidactylus garnotii* D. & B.

Hemidactylus garnotti Duméril and Bibron, Erpét. Gén. III. p. 368; Stejneger, Proc. U. S. Nat. Mus. XXI. p. 792.

HAB. Kauai, Oahu, Molokai, Maui, Hawaii. Frequently seen in houses, and ranges from the coast to 2000 ft. in the mountains. In the open country under stones, logs, &c., in the woodland districts under bark of trees.

GEHYRA Gray.

(1) *Gehyra mutilata* Wieg.

Gehyra mutilata Wieg., Herp. Mex. I. p. 54.

Peropus mutilatus Stejneger, op. cit. p. 796.

HAB. Kauai, Oahu, Maui, Hawaii, and no doubt on the other islands. More rarely seen in houses than the preceding, but found with it under stones, bark of trees, &c. up to nearly 2000 ft. in the mountains of Oahu.

LEPIDODACTYLUS Fitz.

(1) *Lepidodactylus crepuscularis* Bavay.

Hemiphyllodactylus leucostictus Stejneger, op. cit. p. 800.

HAB. Kauai, Oahu, Hawaii, and no doubt on the other islands. Apparently the least common of the geckos; found in houses, under bark of trees, on bananas, &c.

(2) *Lepidodactylus lugubris* D. & B.

Lepidodactylus lugubris Dum. and Bibr., Erp. Gén. III. p. 304; *Lepidodactylus lugubris* Stejneger, op. cit. p. 788.

HAB. Kauai, Oahu, Maui, Hawaii, and no doubt on the other islands. Extremely common in many houses as well as outside. A valuable species, destroying large numbers of the small white-ant (*Calotermes*), which infests the houses in Honolulu and elsewhere.

OBS. In Honolulu and in many other localities this is by far the most numerous of the geckos, and the most partial to houses. Rather before sunset, at the time when the *Calotermes* issue in swarms from the rooms, these lizards may be seen moving actively around on the verandahs outside in pursuit of their prey, the larger occasionally driving off the smaller individuals, and constantly uttering their faint cry as they run along the woodwork, elevating the fore-parts of the body to the greatest extent possible. Unfortunately like the other geckos they are somewhat clumsy hunters and fail to catch a large proportion of the insects they pursue.

Fam. SCINCIDAE.

LYGOSOMA Gray.

(1) *Lygosoma noctua* Less.

Lygosoma noctua Lesson, Zool. Voy. Coq. II. i. p. 48.

Leiolopisma noctua Stejneger, op. cit. p. 805.

HAB. Kauai, Oahu, Hawaii, and probably on the other islands.

(2) *Lygosoma cyanurum* Less.

Lygosoma cyanurum Lesson, op. cit. p. 49.

Emoia cyanura Stejneger, op. cit. p. 807.

HAB. Oahu, Molokai, Hawaii, and probably on the other islands.

OBS. A specimen from Oahu is almost identical in colour with that of the original figure.

ABLEPHARUS Fitz.

(1) *Ablepharus boutonii*, var. *poecilopleurus* Wieg.

Ablepharus boutonii, var. *poecilopleurus* Wiegm., Nov. Act. Acad. Caes. Leop. Carol. XVII. i. p. 202; Stejneger, op. cit. p. 811.

HAB. Kauai, Oahu, Molokai, Maui, Hawaii. From the coast to nearly 2000 ft. in the mountains; abundant.

AVES.

General introductory remarks.

1. The Birds of the Hawaiian islands, though few in number of species, compared with the Molluscs and Insects, are an important group and attracted the attention of the early visiting naturalists, who practically entirely neglected the larger groups. The work accomplished by the various workers at this avifauna up to 1892 has been fully dealt with by Prof. Newton in his paper published in "Nature" in that year. Since that time the elaborate works of Messrs Wilson and Evans and of the Hon. Walter Rothschild have been completed, and two other still more recent publications remain to be noticed. The first of these is a "Key to the Birds of the Hawaiian Group" by Mr William A. Bryan, curator in the Bishop Museum at Honolulu, consisting entirely of technical descriptions of species introduced and native, but without any notes of habits or of habitat other than the name of the island. The whole work is arranged on a strictly dichotomous plan, and is amply sufficient to enable anyone with a knowledge of the terminology of the descriptive ornithologist to at once distinguish the species of Hawaiian birds. The second is entitled "A complete List of the Birds of the Hawaiian Possessions, with notes on their habits," and is at the present time only partly[1] published ("Hawaiian Annual" 1902). It is written by Mr H. W. Henshaw, of Hilo, Hawaii, and much more space is given to an account of the habits of the birds, and to a consideration of questions of general interest, than to technical descriptions, which are reduced to the utmost brevity consistent with utility. These biological notes I have found of great interest, perhaps all the more so as they have mostly been made from constant observations restricted to a comparatively small area of the large island of Hawaii, and it is quite evident that in the case of some birds, habits rarely or perhaps never seen in that area become very noticeable in other localities. When one compares this list with that published in the same Annual in 1879 the enormous advance made in our knowledge of the Hawaiian avifauna during recent times can be readily estimated.

2. I have not considered it necessary to give any technical descriptions of the species, even those most recently discovered having been already described by various authors four or five times on an average. For the same reason all questions of synonomy and the synonyms themselves are entirely omitted, since either Wilson and

[1] Since the above was written Mr Henshaw's list has been completed and published as a separate work.

Evans' or Rothschild's work is necessary for anyone who wishes to make an extensive study of the Hawaiian birds; and in both of these much space is given to these branches of the subject. For the ornithologist who is on a passing visit to the islands, or the resident who takes some interest in the birds of the islands, Henshaw's work when completed will be most convenient, and supplies a distinct want, while it is not less interesting to those who have made a more extensive study of the avifauna.

3. For present purposes the Hawaiian birds may be divided into two very strongly contrasted groups, (1) those that are entirely confined to the mountain-forests, (2) those which at least to a large extent frequent the open country, coast, or sea. To the former belong all the native Passeres, and these form by far the most interesting part of the avifauna. Excluding those which man has introduced within recent years, every Passerine species is peculiar to the islands and comparatively few are found on more than one of these. The second group is largely made up of sea-birds, ducks and waders, mostly of little or no interest in connection with a special study of this fauna, since very few of them are peculiar to the islands, and of these one or two (e.g. *Anous hawaiiensis*, which extends its range to Laysan, and *Puffinus newelli*) will very likely prove to have a wider distribution than is at present known. Many of them indeed are regular winter immigrants, but, owing to their entirely different nature, they throw no light on the question of the derivation of the other and more interesting part of the fauna. Scattered amongst them, however, are a few more interesting forms, especially the duck, *Anas wyvilliana*, the goose, *Bernicla sandvicensis*, the coot, *Fulica alai*, and the stilt, *Himantopus knudseni*, all peculiar to the islands. With these we may include two mountain forms, not Passerine, the extinct flightless rail (*Pennula*) and the buzzard (*Buteo solitarius*).

4. In these general remarks I shall deal only with the Passerine birds and shall briefly discuss the others in their proper order in the following list.

Excluding those lately introduced by man there are 49 species of this Order, and these represent five families, viz. Corvidae, Turdidae, Muscicapidae, Meliphagidae, and Drepanididae. The last-named, which is peculiar to the islands, includes the bulk of the species, these being 35 in number and distributed in no less than 17 genera. The Meliphagidae contain 5 species in two very distinct genera, both peculiar to the islands, one with a single, the other with four allied species. The Turdidae have five allied species, constituting a single very aberrant genus; the Muscicapidae three species, forming a peculiarly Hawaiian, but not isolated genus. The Corvidae are represented by a single species of *Corvus*.

Thus one (and that by far the most richly represented) family, all of the 22 genera excepting only *Corvus*, and all of the 48 species are peculiar to the islands.

These 48 species are in my opinion the descendants of at least six and not more than seven successfully immigrant species of Passerine birds. If the larger number be admitted this would mean two distinct (but closely allied) ancestral forms

for the Drepanididae; but it seems to me more probable that these were developed in the islands from a single form. The structural characters exhibited by the many genera of Drepanididae are such that in no case is any single genus very isolated from that nearest to it, although the extreme forms are so widely separated. The division of the family into two lines of descent, if it be made, must certainly be based on differential characters which would appear to some ornithologists of minor importance, and these will be found fully stated in the table concluding my introductory remarks on the family. If we admit two ancestral forms it is probable that these reached the islands at nearly the same remote period, whereas in the Meliphagidae, of which there were certainly two immigrant ancestral species, it is most probable that the two immigrations took place at widely separated periods of time, and also that the original immigrants were themselves widely separated species.

As the species of Drepanididae are far more varied and numerous than those of the other families, so it is probable that the arrival of the stock, whence they are descended, much antedated that of the others. No doubt the Meliphagine Oo (*Acrulocercus*) is also an ancient colonist, but it has never been able to give rise to a second type of its family, either generic or specific, on any one island of the group; and herein it differs vastly from the Drepanididae, where numerous varied forms live in company on each and every island.

It might be supposed that the period of the occupation of the islands by *Acrulocercus* has been too short for the origin of new forms, but this is hardly likely considering, (1) the peculiarity and isolation of the genus as now constituted, (2) the considerable difference in form and the enormous difference in habits of the species inhabiting Kauai as compared with those on the other islands.

Far more likely to be the true reason is the fact that prior to the arrival of the ancestral form, which yielded the existing Oo, the islands were already fully stocked with diverse forms of nectar-eating Drepanididae, already become specially adapted to the existing flora and peculiarities of climate, while with these the new-comer had to compete, and but for its superior bodily strength might even have failed to hold its own. Is it not possible that the constant antagonism shown by the Oo to some of the Drepanididae of similar habits—attacks which now appear so unnecessary and unprovoked—may be the still surviving expression of that old hostility, which in earlier times was necessary to the bird's very existence? For similar reasons it is probable that the Oo of Kauai so far changed its habits as to become insectivorous to an enormous degree as compared with its relatives on the other islands, and its form is likewise changed and adapted to its habits. So too in the Drepanididae themselves the necessity for acquiring diverse food has led to the strange developments of structure exhibited by many of the present-day representatives. We can now see all stages in the change from a nectar-eating habit to a frugivorous or insectivorous one. Thus *Chlorodrepanis* feeds very largely on nectar and on insects, perhaps generally speaking

one might say that about half its food consists of either; *Drepanorhamphus* is almost entirely a nectar-eater, *Heterorhynchus wilsoni* entirely an insect-eater, but the other three *Heterorhynchi* are partially nectar-eaters. So too some species of *Loxops* and *Oreomyza* are on rare occasions nectar-eaters, the rest purely insectivorous at all times.

Chaetoptila, the other Meliphagine genus, now extinct, was probably a much later arrival than the Oo, and would have had to contend not only with these but also with Drepanididae of similar habits. It appears to have been restricted to a limited area on the island of Hawaii only, and would have been particularly liable to succumb to slight changes brought about by civilization. It is not impossible, however, that, existing in so limited an area, and probably weak in numbers, its extinction was due to natural causes.

Phaeornis of the Turdidae is also an ancient colonist, and, comparing the known species with those of the Meliphagine *Acrulocercus*, we find the development to have been in many respects similar. Thus the former has four and the latter three very closely allied species, and each has in addition a species aberrant in form and highly aberrant in habits on Kauai, but with this distinction that, whereas *Acrulocercus braccatus* is widely spread and numerous, *Phaeornis palmeri* is of very restricted range and exists in very small numbers on that island.

The arrival of *Chasiempis* one would judge to be subsequent to *Phaeornis*, and last of all and comparatively recent must have been the arrival of *Corvus*.

The present Passerine avifauna may have been derived from the following types, two American, ? *Corvus* and *Drepanididae*; three or four from the Australian side, *Chasiempis*, *Chaetoptila*, *Acrulocercus*, and ? *Phaeornis*. Until however the affinities of some of these are more definitely determined it would be unsafe to consider the above division as by any means settled.

There is one other point in connection with the evolution of the Passerine fauna which may be noticed here. When the first immigrant species of these birds stocked the island or islands on which it settled, such checks to increase in numbers as existed were probably chiefly due to the extent of food supply, competition being necessarily restricted to the individuals of a single species with practically uniform habits; and it may be supposed that through this contest for food the first new species were subsequently evolved. Later on, as new species and new genera were produced with widely different habits, and new immigrant forms also arrived, so that most sources of food supply were in requisition, both the competition would become more severe, and the relation of species to species more complex. Nevertheless this complexity is after all infinitely less than that observable in other countries, where a much greater variety of birds exist having directly or indirectly much influence on one another, not to mention the frequent presence of birds raptorial and predaceous, of mammals and reptiles. Such can have had little or no effect on the avifauna of these islands, since either they do not exist or are of small importance in this connection. The short-eared owl is abundant, but it does not enter the depths of the forests, where

is the true home of the Passeres. The buzzard (*Buteo solitarius*) is entirely restricted to one only of the islands, and though it will eat birds and eggs its food is largely derived from other sources. Moreover we can hardly suppose that either of these isolated birds has existed sufficiently long in the islands to have any important effect on the others. Consequently the Hawaiian Passeres furnish excellent material for the study of evolution of species, on account of the comparatively simple problem presented in their case.

CORVIDAE.

Corvus Linn.

Native name *Alala.*

The Alala is entirely confined to the large island of Hawaii, and even there is restricted to a limited area, namely, to the adjoining districts of Kau and Kona. In both of these districts I found it abundant locally during the first years of my collecting, but less abundant in some localities at a later period, partly owing to the fact that it suffers some persecution on account of its depredations, and partly on account of the great changes induced in some of its haunts by the presence of cattle. In the wet belt of the Kona district it was extremely numerous, especially inhabiting the open park-like country between the lava-flows, where dense masses of clinging Ieie (*Freycinetia*) invested the scattered trees. In these it nested freely, and numerous nests containing young were found in the summer months. At this time it was extremely tame and would often follow the intruder for a considerable distance, repeatedly uttering its harsh cries, thereby often attracting others from a distance, perhaps to the number of a dozen, the whole assemblage raising a deafening clamour. Here also it found abundant food in the large red fruit of the Ieie, which in this district attained unusual size. A few shot for dissection were absolutely filled with this food to the exclusion of all other, but numbers were noticed at odd times on the ground feeding on the decaying flesh of dead cattle. After the ripe fruit of the Ieie had disappeared a partial migration to a higher altitude in the mountains took place, and here the crows were eating the ripe berries of the Poha (*Physalis*), again varying this diet with the flesh of dead horses or cattle. Some years later wishing to get some skins in good condition I revisited this locality and found an evident decrease in the number of these birds, and those which I saw were decidedly less tame, but the required specimens were very easily obtained, since they readily respond and approach when their cries are imitated.

Although the Alala has now a wide range of food, yet this habit is probably lately acquired, and simply a reversion to the custom of its ancestors, rendered possible by the change of conditions that has taken place in the islands of late years. Thus carrion could have formed no part of its food, or at most an insignificant one, before the white man brought his cattle, nor before his arrival could it have obtained some other kinds of food to which it is now partial. It is however possible that at a time when the forest extended much lower than it now does, when the trees on the coast of the Kona district were, as

we know, frequented by several forest birds which now are never seen there, the crow also visited these parts and obtained such animal food as it required amongst the shore refuse, as crows are wont to do in other countries. The deficiency of our knowledge of the conditions of the avifauna at a time when the country was still largely unchanged is much to be regretted, since the older explorers could so easily have supplied this, either from their own observations or on information derived from the native bird-catchers. It is at least probable that the Ieie yielded the chief food supply of the Alala under natural conditions, since I saw the old birds feeding their young with this food. Although the crow is said nowadays to eat the eggs and young of imported species of birds, it is hardly likely that it habitually molested native species. Thus many small native birds were abundant in the same trees as the Alala, but they seemed not to be in the least disturbed by the presence of the latter, and the Ou (*Psittacirostra*) might be seen feeding on the same food and in the same clump of Ieie.

The Alala is by no means deficient in powers of flight, and in early spring I frequently noticed them rising to an immense height in the air, often several together, where they could be seen playing or fighting on the wing. This habit makes it still more extraordinary that their distribution should be confined to so small an area, for one would have expected on this account that, even if not accidentally transported by sudden storms to other of the islands, they would at least have been universally distributed over the large one. It might be suspected that the climatic conditions of those districts, from which the crow is absent, must be adverse, since the food supply in most places is certainly not so. Yet, as we have seen, this bird readily migrates from the wet belt to the upper dry forest in Kona, which have distinctly different climates, and moreover, in the wet belt itself the weather differs very greatly in summer and winter. It is questionable therefore whether, if it extended its range to some parts of windward Hawaii, from which it is absent, it would encounter a greater climatic change than it now experiences in its own district. The young will live at least for a considerable time, and so far as I know for their natural life-time, in captivity, under conditions far from normal. The cause of the restricted range of the Alala is an unsolved enigma and to me inexplicable.

(1) *Corvus hawaiiensis* Peale.

HAB. Hawaii; abundant in Kona and Kau.

TURDIDAE.

PHAEORNIS Sclater.

Native name *Amaui* (syn. *omao*, *olomao*, *kamao*, &c.).

There are five known species of this genus, two of which inhabit Kauai, one the neighbouring islands Molokai and Lanai, one Hawaii, while the fifth was formerly found on Oahu, but is now extinct. The native names cited as synonymous are those now in

general use over the islands, but they appear to me to be clearly corruptions of the true name, if not altogether wrongly applied. It is at least singular that the word "omao," meaning "green," should have been applied to a bird which is not at all green, and this in a country where the avifauna consists largely of green species. The word "amaui" I obtained from a very old source, as used by the old Kauai natives for the *Phaeornis* of that island, and to the Hawaii species the same name is applied in manuscript notes made by Bloxam in 1825, who there calls it "Amauee," spelling the word as it sounds to English ears. That a bird so conspicuous for its fine song should have been dedicated to the celebrated Polynesian demigod is quite natural, and it is hardly likely that the "manu amaui" or Maui's bird would have been known under a variety of names in olden days.

Excepting the small *P. palmeri* of Kauai, the slightly modified species of this genus are practically identical in their habits. All are largely frugivorous, feeding voraciously on the berries of the various forest trees. Throughout the islands the berry of the Opiko (*Straussia*) is perhaps in general their favourite food, but those of the Pua (*Olea*), Olapa (*Cheirodendron*), and many others are much sought after. From the stomach of a specimen of *P. lanaiensis* I took an entire unripe fruit, so large that it alone entirely filled the cavity, and even with its large gape the bird must have had some difficulty in swallowing it. *P. myiadestina* at certain seasons and in some localities on Kauai feeds almost entirely on the berries of the poisonous Akia (*Wikstroemia*). Besides berries the Amaui feeds on various insects, both winged and those in the larval state, as well as upon spiders and myriapods. When hunting the more active of these, it is lively and quick in its movements, making sudden rushes forward, often assisted by its wings. The species of Hawaii and Kauai are to be found in the largest forest trees as well as in the underbrush, but that of Lanai and Molokai, where the forest growth is generally much less tall, is equally abundant amongst small trees and bushes. All these birds are partial to caterpillars, especially those of Geometrid moths, commonly called "loopers" or span-worms, the peelua kuapuu of the natives (i.e. hump-backed caterpillars). They also continue to feed the young on these for some time after they have left the nest. In the earlier summer months of 1895 the Amaui of Hawaii was absent from the Koa woods above Kilauea on the Kau side, but in August there was a large incursion of this bird into these woods in company with the Ou (*Psittacirostra*). At this time the trees were defoliated by myriads of Geometer caterpillars, and on these the two were constantly feeding, both again disappearing after some weeks. Probably they came from the forests on the Olaa side, where they were numerous at all seasons. I noticed a similar accession to the ordinary residents under similar circumstances on the Kona side of the same island, but in this case it was less noticeable, owing to the locality being well stocked on all occasions. Henshaw remarks that of numbers dissected by him not 5 per cent. contained insect food, which is no doubt correct at certain times and places, but this statement would be far from true in cases such as I

have just mentioned. Rather often these birds descend to the ground in the more open woods of the upper forest in Kona, where the ground is covered with dry phyllodes of the Koa, or amongst large fallen branches of these trees. In the same district, where they are extremely numerous, they sometimes catch insects on the wing with much expertness for such heavy birds, much after the manner of the fly-catchers.

As to the distribution of the various species, each in the island it inhabits, I have found all to be almost ubiquitous throughout the forest, wherever birds are found, from the lower limits to the upper, not only in the densest parts of dense forests, but also in the more open woods. In the lower forest of the Kona district, though perhaps more numerous on the rough lava-flows with their denser vegetation, the Amaui was common among the scattered trees of the park-like country between the flows. Here the trees covered with dense masses of climbing Ieie (*Freycinetia*) still afforded fine shelter, but seemed likely to do so for no long time, seeing that this covering was being rapidly stripped off by the cattle, of which it is a favourite food. In Molokai *P. lanaiensis* still lingers in remnants of forest from which all other native birds have disappeared, but of course it is much more plentiful in denser woods.

All these species when alarmed assume a similar attitude, drooping their wings and giving to these a shivering motion. Henshaw says that he has seen the bird go through this performance of its own accord when he himself was unnoticed, but it is doubtful whether in such cases the observer is really unnoticed. If one comes suddenly on one of these birds in the denser forests it will generally at once assume the characteristic posture and movements, but after a short time will begin to feed unconcerned within a few yards of the observer. In such cases the slightest movement on the part of the latter is sufficient to bring on a renewed attack of shivering. When one is standing in the dense forest, one can often hear the alarm note of several of these birds coming from various directions, when not a single individual can be discovered by the most careful scrutiny, showing that they are very quick to detect the presence of an intruder. For these reasons I think it is certain that these postures are essentially the result of alarm, but whether produced also by other emotions it would be very hard to say. I have certainly often been able to observe *Phaeornis* in the brush surrounding my tent, when this was closed except for a narrow chink, without any shivering attack being produced, while at other times the mere presence of so strange an object as a tent is apparently of itself sufficient to bring on one of these.

In my notes published in the "Ibis" in 1893 I called attention to the several points of similarity between the habits of *Phaeornis* and the fly-catchers of the genus *Chasiempis*, and in his recent paper Henshaw makes practically the same observations.

The song of the Hawaiian thrush surpasses in beauty that of all other native birds, of which one or two at the most have any claim to be considered as more than second-rate songsters. Lavish of its song, numerous and almost ubiquitous throughout the forests of the islands on which it is found, its voice more than atones for the sombre

inconspicuous colours of its plumage. It is certainly much inferior to that of the common European song-thrush, being less melodious, far more jerky and less sustained. The wild outburst of song, which the Amaui pours forth on the wing as it descends from the top of a lofty tree to lower cover, can hardly fail to strike the attention of any-one who wanders through the forest. Often individuals sing in turn, as it were in rivalry of one another, the one beginning its song immediately after the other finishes. Sometimes several take their part in these concerts, and the performers may be stationed in trees only a short distance apart, or the one most distant from the observer may be only faintly audible. Whether in the breeding season or at other times, they are fond of special stations, and will sing at intervals during the whole day, and day after day from the same tree, and even from the selfsame bough. The alarm note is highly peculiar and characteristic, sounding like "quah," and this sound when uttered by one is readily taken up by others in the neighbourhood and at a distance. The Amaui is of all birds the first to make itself heard in the morning. Both in the uplands of Kona and the wet forests of Molokai I have heard it in full song while the stars were still shining and some time before the first grey of dawn appeared.

Besides the alarm note it has a very distinct simple whistle for a call note to which it will readily respond and by imitating which it may even be called close to the observer. It may be observed that these birds are distinctly of practical use in the forest, not only because they kill considerable numbers of insects, which are decidedly injurious, but still more because they surpass all the other birds in scattering the seeds of forest trees. Passing undigested through the bird, as most of these and perhaps all do, they are deposited in a condition suitable for germination, and it is perhaps due to this that the trees, to the berries of which they are most partial, are now so widely spread.

I have several times found the nest of *Phaeornis* but have never been so fortunate as to take the eggs. A nest of *P. obscura* was found in a Mamani tree in the uplands of Kona, but was not completely built. Unfortunately Mr Scott B. Wilson, who arrived in Kona to make a special search for the eggs of native birds on the eve of my departure, was unable to find the marks I had made in the forest, which would have led him to this nest. Quite recently I found two nests of *P. lanaiensis* on the island of Molokai both fresh and apparently nearly complete. One of these was placed in an Ohia tree at the height of about 25 feet from the ground in the midst of a thick forest, the other in the top of a Koolea tree (*Myrsine*) at about the same height, but far below the dense forest, in a locality where no other native birds except *Phaeornis* existed. In each of these cases a pair of old birds were continually in the vicinity of the nests, which were of simple structure, much like those of the Drepanididae, but of much larger size, built of dried leaves, twigs, and rootlets.

The smaller of the two Kauai species, *P. palmeri*, differs so much in its habits from the other members of the genus that it is necessary to consider these apart. Not only

is it by far the rarest and most local of the Hawaiian thrushes, but it is also much more strongly separated by structural differences from the others than are they from one another. Its larger relative on the same island is especially numerous in the same locality as the species now under consideration, and after spending three weeks in specially studying this bird, I came to the conclusion that in this locality the larger was at least one hundred times more numerous than the smaller species. Owing however to their totally different habits there is little or no competition between the two forms, as at present constituted. If it should prove that this bird is really restricted to the area over which alone it has so far been collected, it is perhaps the most localized of any forest bird, surpassing even *Viridonia* and *Chloridops* of the Drepanididae in this respect.

P. palmeri chiefly frequents the underbrush and smaller-sized forest trees, rarely perching at any great height from the ground. It may be seen flying with a straight swift flight beneath the lower branches of these trees, sometimes alighting on a dead twig at a height of not more than three feet from the ground. More rarely it actually settles on the ground, and in one shot in this situation I found a small terrestrial species of land shell. When it alights on a really large tree it is usually on the lower branches, excepting only when about to sing, on which occasions it will perch on the topmost branches of one of the tallest trees in the vicinity.

All the specimens obtained by me proved on dissection to contain the large hard weevils of the genus *Rhyncogonus*, and these unquestionably form a large part of their food. Spiders and caterpillars are also eaten, and the insectivorous habits of the species are strongly contrasted with the berry-eating propensity of the other members of the genus. On one occasion I saw an old bird carrying a very large green looper caterpillar held crosswise in its bill, which was evidently intended either for its mate or young. It perched only a few feet directly above my head, exhibiting extreme agitation, but presently flew off and I was unable to trace it to its destination, owing to the thick fog and gathering darkness.

The young probably do not lose their spotted plumage for two seasons. One very foggy morning I saw a pair of birds in such plumage, on a low branch, not standing in the usual erect position, but squatting side by side and actually touching one another. Their feathers being much puffed out, they looked fully as large as the larger *Phaeornis*, when seen through the foggy air, and after a glance I passed on supposing them to be the common species. Returning considerably later I found this pair in exactly the same position and this time took a long look at them and again passed on, but feeling dissatisfied turned back and frightened them from their perch. Then I saw at once that they belonged to the smaller species, and killed the two at one shot in the neighbouring tree to which they had flown. On dissection they proved to be male and female, with the testes and ovaries very much enlarged, in fact in the condition of birds either breeding or about to breed. It will therefore probably be found that in this respect too *Phaeornis* (at least *P. palmeri*) resembles *Chasiempis*, the latter not very rarely breeding whilst still

clothed in the ochraceous plumage of the young. It may be worth remarking, as showing the rarity of this bird, that although on the occasion mentioned I saw eight different individuals of *P. palmeri*, only on one or two other occasions did I see half this number on any one day, although I was fortunate enough to learn its alarm note and song at the very beginning of my search, and this in a thickly-forested district is of course an enormous advantage.

The song of the small *Phaeornis* is entirely different from that of the other species and is a simple trill with much resemblance to that of the Akialoa nukupuu (*Heterorhynchus*). When singing it frequently perches amongst the highest branches of tall trees and is seen with difficulty. The habit of singing on the wing is still retained, though the song itself is so much changed. The alarm note too is a squeak and entirely different from that of its larger relatives.

The extinction of the Oahuan species of the genus is a most singular fact, when one considers that *P. lanaiensis* was found so commonly in the much smaller forest area of Lanai, and on Molokai still remains in spots whence the other native birds have vanished. It may be, however, that the Oahuan bird had very special habits, as appears to be the case with the small Kauai species, and that for this reason its range was also very limited. The fact that it does not seem to have been observed by any of the old collectors except Bloxam would lead one to suspect this to be the case. I believe that a *Phaeornis* also formerly inhabited Maui, for I was assured by a native who was familiar with the birds that thirty years ago the Amaui was abundant in the Iao valley, and he particularly mentioned and described the song. If this was so, the causes of its extinction are even more inexplicable than are those which destroyed the Oahuan species.

(1) *Phaeornis obscura*, Gmelin.

HAB. Hawaii; generally distributed and common.

(2) *Phaeornis lanaiensis* Wilson.

HAB. Lanai and Molokai, in the mountain forests, common.

OBS. Rothschild credits this bird to the 'lowlands' of Lanai, meaning no doubt the lower part of the forest, which is far removed from the lowlands, where no *Phaeornis* could exist.

(3) *Phaeornis oahuensis*, Bloxam.

HAB. Oahu formerly; now extinct.

(4) *Phaeornis myiadestina* Stejneger.

HAB. Kauai; generally distributed and common.

(5) *Phaeornis palmeri* Rothschild.

HAB. Kauai, on the high plateau. Local and not common.

MUSCICAPIDAE.

CHASIEMPIS Cabanis.

Native name *Elepaio.*

There are three known species of this peculiarly Hawaiian genus of fly-catchers, one restricted to each of the forest-bearing islands at the north-western extremity, Oahu and Kauai, the third to Hawaii at the other end of the group. On the three intermediate islands the genus is not represented. Similar instances of partial, where one might expect universal distribution are found not only amongst other genera of birds, but in the molluscs and insects are even more remarkable. The universal distribution over the islands they severally inhabit, from the lowest bounds to the uppermost edge of continuous forest, as well as their extreme abundance and obtrusive familiarity, has caused these birds to be noticed by many persons who have seen no other native bird, so that one is not infrequently questioned by the city resident, who has wandered up the mountains close to Honolulu, about the little brown bird which "looks like a wren." Conditions of climate and environment are as nothing to the Elepaio, which is equally at home on the sharp ridges of Oahu, the boggy summit of Kauai, the dry uplands of Kona, or the rain-soaked forests of windward Hawaii. Nor in any locality is its presence restricted to any special feeding ground, from the tops of the loftiest Koa or Ohia it descends even to the ground, and abounds throughout the underbrush. Fallen trees are often carefully inspected, and it is said that from the actions of these birds the native canoe-makers judged of the soundness of the timber they had felled, ascribing to the Elepaio the rank of a deity.

As the whole forest is its hunting ground, so the food of the Elepaio is very varied, for it not only picks out larvae from unsound timber, and hunts for these along the limbs of large trees, but catches the more active insects which settle on the foliage, readily pursuing on the wing those that fly, and often taking them with an audible snap of the beak. Beetles, mature or as larvae, myriapods, flies, moths, caterpillars, especially loopers or span-worms, but also many others, such as those of the large wood-eating Tineids, gaudily-coloured ones of some native Pyralids, together with spiders and slugs, form the bill of fare. Large moths they often hold down in their claws while they tear off the wings before swallowing them. In pursuit of such food they are active the whole day through, and their restless movements and clear whistle enliven parts of the forest, which are now otherwise almost destitute of bird life. To the changes wrought by civilization they are less susceptible than any other bird, and they may be seen feeding

and even nesting in dense thickets of the introduced guava, or amongst masses of the prickly lantana, as contentedly as amongst the native vegetation. I have often noticed them in the uplands of Kona feeding or sporting amongst the dry fallen foliage of the Koa around the base of the trunk, and in some localities in Oahu they frequently alight and feed amongst the creeping ground ferns as well as on the stems and leaves of the large tree ferns.

When not engaged in feeding or nesting they may often be seen chasing one another on the wing, either two or several individuals taking part in the sport or struggle, and scolding vociferously. The young are particularly tame and curious, and in some parts of the forest it is hardly possible to proceed far without one, two, or several of these coming up to view the intruder. In such cases they know no fear, and will sit around sometimes within arm's length, turning this way and that to make a thorough inspection. Sometimes the inspection is made in silence, but more usually with abundant chattering or scolding which is taken up by others in the vicinity. Not rarely, when their excitement is intense, from the scolding note they burst forth into their full song. This consists of three or four whistled notes, and is excellently expressed by the word "Elepaio," the stress falling on the penultimate syllable. These notes are very clear, so that even across the deep and large gulches of Oahu one can hear the birds on either side responding one to another.

Of all the known nests of Hawaiian birds that of the Elepaio is perhaps the most ornate, and it is by far the most easily found. Individual nests exhibit much variety in size. Of two taken from adjoining trees in the Kona district of Hawaii, containing eggs and young respectively, one was about three times as high as the other, two-and-a-half times as high as wide, and had the appearance of three superimposed nests, but the cavity was only of the normal depth. These nests are built in all sorts of situations, and the height at which they are placed varies much, being generally from 6 ft. to 40 ft. from the ground. I have seen many nests even in the introduced guava bushes both in Hawaii and Oahu. The abundant use of lichens in the construction, which are bound together with cobwebs, gives them a very beautiful appearance. The eggs are whitish, variably marked with reddish spots. Those nests which I have myself observed have always contained two eggs or two young at most, but Henshaw says that sometimes three eggs are found in a nest. Not very rarely the female may be found breeding when it is clothed in immature plumage, and before any trace of the white spots which take the place of the yellowish marks of the young has appeared. In one instance I found both parents in the immature plumage at a time when their young were already pretty well fledged, though still unable to fly. The old males, particularly those of the Hawaii[1] species, when in their finest plumage, have a very attractive appearance, especially when they assume their characteristic attitude, drooping the wings, and raising the expanded tail feathers vertically over the back.

[1] For local variation in colour of plumage see Henshaw in 'The Auk,' July 1902.

(1) *Chasiempis sandvicensis*, Gmel.

HAB. Hawaii; generally distributed and abundant.

(2) *Chasiempis gayi* Wilson.

HAB. Oahu; generally distributed and abundant.

(3) *Chasiempis sclateri* Ridgw.

HAB. Kauai; generally distributed and abundant.

DREPANIDIDAE.

Remarkable as are some other members of the Hawaiian Avifauna, yet it is upon the Drepanid birds that the interest of the ornithologist will always be centred. The Drepanididae, as here considered, include thirty-five species, belonging to no less than seventeen genera. One genus with one species is restricted to the outlying island of Laysan, as is also a second species not generically peculiar, both being included in these remarks on the family, although with the rest of the Laysan Avifauna they may be excluded from the list of Hawaiian forms. The total number of species here cited is rather less than that given by the latest writers on the Archipelago, owing to the fact that several forms which have been described as distinct appear to be quite unworthy of such rank.

1. Small proportion of Species as compared with Genera.

If we compare the Drepanid birds with the peculiarly Hawaiian families in other groups of animals, we are at once struck by the very large number of genera accepted, as compared with species. No doubt this is partly due to the very different value attached to characters supposed to be generic by systematic workers in different lines, and also to the large size of birds as compared with many other creatures, owing to which their characters are obvious on the most casual inspection. If we compare the Drepanididae with such a family as the Proterhinidae in the Beetles, which is also peculiar[1] to the Hawaiian Islands, we do not find the latter susceptible of easy division into well-marked genera as in the birds; indeed, at present the members are all included in a single genus. Yet to the student of both groups it is obvious that the extreme forms of the Proterhinidae exhibit differences of structure as great and varied as are found in the extreme forms of the Drepanididae; in fact the variety of structure is probably greater in the beetles. If, however, we were to reduce the hundred and thirty species of *Proterhinus* to the number of species of the Drepanid birds, and particularly if in doing so we were to eliminate the osculant forms, it is manifest that the condition of the two groups would

[1] Since this general account of the Drepanididae (for the most part reproduced from the 'Ibis' for Oct. 1901) was written, I have discovered that a species of *Proterhinus* is found in Samoa.

be strikingly analogous. It is therefore in my opinion clear that, making all allowance for the ease with which the one group is studied, and the relatively great difficulty presented by the other, there is a real and great difference between the Drepanididae and the Proterhinidae, and in fact between these birds and most of the other extensive and peculiarly Hawaiian groups of animals, and that the difference is due to the fact that while in the birds there has been a keen competition for existence between the various species and between the individuals of each species, in the Proterhinidae there has been little or none, because the food-supply of the latter, consisting of dead wood, is in a forest-covered country almost unlimited. As will be hereafter noticed, there is good reason to believe that the competition between the birds has been much more keen in past times than during the more recent periods of their existence.

2. Origin of the Drepanididae doubtful.

If we compare the Drepanididae with other families of birds, it is obvious that, considering the few species that exist, they exhibit an unusual diversity of structure. As a proof of this, it is only necessary to mention the fact that competent ornithologists have repeatedly assigned to different families even those forms which without any possible doubt belong to the same. This diversity of structure must have required a vast time for its evolution, and the period at which the ancestral Drepanid immigrated to the islands must have been very remote indeed. Whether all the existing species of this group have been evolved from one original immigrant or from more we cannot say; but the former view is probably the more correct, although two ancestral immigrants might be admitted.

That the islands were originally stocked by *numerous* species which produced the present family is highly improbable, seeing that whole families of birds far better adapted to cross wide extents of ocean were quite unrepresented in the Hawaiian Islands, although we know that some of them thrive exceedingly when imported, and many others would no doubt do so under similar circumstances.

Whence the ancestors of the present Drepanid birds came is, owing to their dubious relationships with outside forms, still an open question; though if it were certain that their closest relationship was, as Dr Gadow has suggested, with the Cœrebidæ, little doubt would remain as to their American origin. For the present it is perhaps safer to consider them, with other peculiarly Hawaiian groups, as being of unknown origin.

3. Two Groups of Hawaiian Drepanid birds exist, indicating either two distinct original immigrants or, more probably, very early divergence from one ancestor in two directions.

I have already stated that a dual origin for the present Drepanididae is conceivable, and is indicated by the fact that they fall clearly into two groups. The first of these

contains six genera, viz. *Drepanis*, *Drepanorhamphus*, *Vestiaria*, *Himatione*, *Palmeria*, and *Ciridops*; the second the remaining eleven.

The genera of the first group are characterized by the truncate apices of the primaries, except in the anomalous *Palmeria*, and by the plumage of the young, which is always partly black or of a dull colour. In the adults white markings are present, either on the wings or on the upper parts of the body. The skin, moreover, is comparatively thick, and sometimes extremely tough and thick, as cannot fail to be noticed by the collector when using very small charges of powder and shot to procure specimens. The plumage of the sexes is identical or nearly so. Red colours are acquired by the adults of some species in both sections, but in a totally different manner; in the second group it is invariably through a green or olivaceous stage, while green-plumaged forms are never found in the young of the first group. In addition it may be noted that the songs and cries of the members of the first section are of a very different character from those of the second, between most of which there is a striking general resemblance in this particular. Further, all the members of the former which are known to me in life (*Himatione*, *Vestiaria*, *Palmeria*, and *Drepanorhamphus*) have a peculiar, noisy flight, so that the sound caused by their wings, when they fly freely, can be heard at a long distance.

In the second group the primaries are never truncate at the apex; the young, moreover, are invariably clothed to a large extent in green or olivaceous plumage; and this colour nearly always persists in the adult female, although it may be totally lost in the adult male. Such is the case in several species of *Loxops*, the green coloration in this genus being largely permanent in the male of the Kauaian species only (*L. caeruleirostris*). There are almost always well-marked distinctions of colour between the adults of either sex. In a few forms which retain in the adult male and female the green plumage characteristic of immature birds (e.g. *Viridonia* and *Chloridops*) there is little or no difference in the colour of the sexes; but very rarely is this the case when the adults acquire a special coloration, as in *Loxioides*, in which the head is yellow, though somewhat less brightly coloured in the female.

To those who believe in the great significance of the very different character of the coloration of the young birds in these two groups (whatever change may take place in the adults), as well as of the development of striking sexual characters throughout nearly the whole of one of them, the necessity of distinguishing clearly between them will be apparent.

4. Development of Species in each Group along similar lines, and the reason for the same.

When we examine, side by side, a full series of the forms it is obvious at a glance that each group has developed along similar lines. *Himatione* and *Palmeria* of the first are in general structure very like *Chlorodrepanis* and *Viridonia* of the second; *Drepanis*

and *Drepanorhamphus* resemble *Hemignathus*; *Ciridops* may be compared with *Loxops*.

With *Ciridops* in one direction the evolution of forms in the first group ceases, while from *Heterorhynchus* the second proceeds through *Pseudonestor* to a series of thick-billed birds quite unrepresented in the first. Consequently in discussing these remarkably analogous forms the six thick-billed genera will here be excluded. Turning to the habits of the birds of the remaining twelve genera, eleven of these certainly and all probably (the habits of *Ciridops* being little known) contain at least some species accustomed to feed on nectar[1]. *At the present time* the main supply of this food is derived from the *Metrosideros*—the well-known "Ohia-lehua" of the natives, and the predominant tree in the forests of all the islands. Around the masses of red blossoms of these trees may be seen at the proper season an assemblage of various kinds of birds, the scarlet "Iiwi" (*Vestiaria*) and the green or yellow "Akialoa" (*Hemignathus*)—both with long curved beaks,—the crimson "Apapane" (*Himatione*) with moderate straight bill, and the green "Amakihi" (*Chlorodrepanis*) with moderate curved bill. The observer wonders for what purpose such extraordinary developments can have taken place. On the same flowers are numerous bees peculiar to the islands, shortest of all short-tongued bees, with a tongue one millimetre long, yet as well able to feed on the nectar as the "Akialoa" with its tongue of two inches or more. An examination of the *Metrosideros* tree will show that it is a species not peculiar to the islands, although, as above remarked, it forms so large a part of the whole forest. In its specific characters it is in a remarkably unstable condition, exhibiting many striking variations, as though it were now in process of being differentiated into several species. Many of these variations are of constant occurrence and widely spread; some are deemed worthy even of specific rank.

These facts appear to me to point to a comparatively recent "immigration" of this tree, and I cannot suppose that it has existed on the islands for the period of time which would have been necessary to produce the exceptionally great variety of structure exhibited by the Drepanididae. Turning to other sources whence the food-supply may have been derived at a period antecedent to the arrival and spread of the "Ohia-lehua," we find very different conditions. All[2], or practically all, the plants visited by these

[1] Not that nectar is ever the sole food, though a most important source of nutriment—so important to the adults of some species that at certain seasons no individual shot contains any trace of insect food. Few Hawaiian insects frequent flowers, and such as do, viz. one or two beetles and the Hymenoptera, are seldom if ever found in these birds' stomachs. Nectar is undoubtedly absolutely necessary to the existence of *Himatione*, *Chlorodrepanis*, *Vestiaria*, *Hemignathus*, and *Drepanis*, as they are constituted; small moths, caterpillars, and spiders—their other food—would certainly fail them in sufficient quantity at certain seasons. The honey-sucking Drepanids and the "Oo" can be kept alive on nectar and sugar-cane juice. When a species becomes purely insectivorous here it shows extreme modification, e.g. *Pseudonestor* and some *Heterorhynchi*, so that it may obtain special insects inaccessible to other forms.

[2] We exclude from consideration the *Eugenia*, a local species, the blooms of which are superficially like those of *Metrosideros* and are attractive to birds; it is known outside the islands, and was probably introduced by the early native settlers.

birds for food had bell-shaped or tubular blossoms, in which the nectar was more or less hard to reach. Of these tubular-flowered plants there are several predominant genera, some of which are themselves restricted to the islands, and belong to various families, comprising hosts of peculiar species. Most striking of all are the arborescent Lobeliaceae, not closely related to forms found in other countries. The multiplicity of these peculiar plants, and their isolation from foreign forms, bears a striking resemblance to that of the Drepanid birds themselves, indicating likewise an extremely ancient occupation of the islands; and as the latter are the pride of the Hawaiian ornithologist, so are the former of the Hawaiian botanist. To these flowers Drepanids of both sections are still partial, and some particularly so, and the development of their extreme forms is not comprehensible without a knowledge of the island flora. That there has been in the past severe competition for food between the various species which have similar habits, and between the individuals of each, cannot be doubted. The number of birds that can exist in a given area is obviously only that which can be supported when the food-supply is at a minimum. At the present day, when the "Ohia" is in bloom over miles of country, the food-supply seems inexhaustible; but between the flowering periods it is limited, and often leads to a decided migration of the birds either from one district to another, or to different elevations in the same district, where, owing to the varying climate, the trees blossom at different seasons. Certainly the arrival of the "Ohia" must have been a powerful agent in the increase of individuals of honey-sucking species; and the competition for food must have been much more keen previously. I can hardly doubt that the primitive Drepanid was a honey-sucker, and that the now purely insectivorous, as well as the thick-billed frugivorous forms, were a later development, although the honey-suckers were no doubt at all times partly insectivorous, as they are at present. With the increase of the insect-fauna there would certainly be a tendency among the honey-sucking forms to become more largely, or even entirely, insectivorous, as in fact has been the case. The examination of a series of species of the Lobeliaceae will show great differences in the length of their flowers; and while in some the nectar can be reached by the moderate tongue of *Chlorodrepanis*, in others it can only be procured by the extremely long-billed and long-tongued forms of Drepanids, and the long-tongued Meliphagine "Oo," the latter also a peculiar and probably very ancient denizen of the islands.

A series of observations made on one of the most superb of the Lobeliaceae showed that it could only be fertilized by these highly specialized birds. In this species the pollen is mature before the stigma is exserted, by which time the pollen has vanished. The latter cannot be wind-borne, because it is shed in a viscid mass on contact, and so is constantly deposited on the bird's forehead, from which it is difficult to remove it. With these considerations in view the cause of the development of the most remarkable forms in each group of birds becomes manifest, and this cause has produced *Hemignathus* in the one, and *Drepanis* in the other, so like one another in general structure,

while really but remotely allied. How easily the extraordinary lengthening of the bill, to which the resemblance is mainly due, may have taken place, side by side with the increasing length of the tubular flowers, is apparent from the fact that in some of the birds there is even now individual variation in this respect. It should also be stated that in immature specimens the beak is much shorter, and that in the freshly-hatched young of *Chlorodrepanis* it is a short, wide member, instead of having a slender curved form, as in older birds. In the long-billed forms the mandibles are almost invariably shorter in the more "conservative" females, which in my second group retain in the adult the more primitive coloration of the young, though the males assume a totally different dress.

5. Transition from a largely Vegetable Diet to purely Animal Food.

Of the genera *Loxops*, *Oreomyza*, and *Heterorhynchus* the members are mainly insectivorous, but each comprises some species which at times feed on the nectar of flowers. In *Loxops* and *Heterorhynchus* the tubular character of the tongue is fully preserved, yet they very rarely feed from flowers, and some of the species perhaps never do so. Certainly that of the latter genus which is found on Hawaii is purely insectivorous, feeding, after the manner of a woodpecker, on beetles and other insects; but the other three allied species are less adapted to such a life, and the Maui form has been known to me to visit blossoms as a very rare occurrence, while the partiality that the extinct species of Oahu had for banana flowers has been noticed by others. That these birds, even when purely insectivorous, still retain the characteristic Drepanid tongue, is clearly due to the fact that it remains a most efficient organ for obtaining insect food—in *Heterorhynchus* for extracting the wood-boring beetles of which it is so fond; and in *Loxops* for securing caterpillars which live in the terminal buds of some forest trees, not to mention other purposes. In *Oreomyza*, on the other hand, the tongue is much degraded from its normal structure, while only two of the species, and those but on the rarest of occasions, have been seen to suck honey, and then only from the shallow "lehua" flowers. The genus is almost entirely insectivorous and feeds chiefly on exposed caterpillars, spiders, and moths.

6. The Thick-billed Species of the Second Group.

There still remain to be considered the thick-billed species of the second division of the Drepanididae, which have no similar forms in the first.

There are seven such forms, distributed in no less than six genera, one of the latter (*Psittacirostra*), with its single unmodified species, ranging over the whole group of forest-bearing islands. One species forming a distinct genus (*Telespiza*) is restricted to the outlying island of Laysan; another, also forming a genus (*Pseudonestor*), is

found only on the mountain of Haleakala in Maui; while three genera with four species are confined to the large island of Hawaii, namely, *Rhodacanthis* with two species and *Loxioides* and *Chloridops* each with one. It is now generally conceded that all these forms are only extreme modifications of the more normal Drepanididae. In my published biological notes it is true that I placed this section under the Fringillidae, but I did so merely in deference to the opinions of systematic workers, Messrs Wilson and Evans and Rothschild, and more particularly to those of Dr Gadow, who had availed himself of the opportunity of carefully studying the different forms side by side, whereas at that time I had secured no such facilities. Personally I was convinced that all belonged to one family—whether called Drepanididae, Fringillidae, or otherwise,—and always maintained this in my correspondence against general opposition, and that too at a time when Mr Rothschild himself was setting forth descriptions of the Drepanids under such diverse families as Fringillidae and Meliphagidae! Although biological considerations first suggested to me the common origin of all the present family—honey-suckers and thick-billed birds alike—yet at a very early period[1] of my study of these birds I had excellent reasons apart from such for my belief. Before the body of the first *Pseudonestor* obtained by me was cold I was well aware that its tongue was essentially Drepanine and little modified, and that it indicated a positive connecting-link between the thick- and thin-billed sections, being, in fact, more typically Drepanid than that of the otherwise normal *Oreomyza*. The tongue of *Psittacirostra* likewise was taken from the bird immediately it fell to show that it was truly Drepanid, although much modified. In a hot country such parts should always be preserved immediately, as after a day's collecting they are liable to dry up and their appearance to become changed. The characters afforded by the nostrils and their opercula in all the important forms, as well as the pattern of colour, had been under my consideration as early as 1894, and it is doubtful whether any other important characters have been advanced since that time.

It is still my belief that the biological or physiological reasons on the strength of which I first concluded that all these birds belonged to one family are of the utmost importance, chief amongst which is the peculiar odour to be noticed in both groups, in the thin-billed and thick-billed forms alike. So far as Hawaiian birds are concerned this odour is absolutely restricted to the Drepanines. Mr Rothschild in his work on Laysan makes the astonishing statement that the Meliphagine Oo has a similar and even more powerful odour; but this is only one of those errors which, for want of due care, the museum naturalist is liable to make in opposing facts ascertained and proved in the field.

[1] It should be mentioned that a long time previously Dr Sclater (cf. "Ibis," 1871, p. 559) had, after a careful study of various Hawaiian forms, expressly declared his opinion that two of the Finch-billed genera (*Psittacirostra* and *Loxioides*) were true Drepanids and related to *Heterorhynchus*—an opinion without doubt correct, since *Pseudonestor* is a connecting-link. It was not until long after I had come to the conclusion that not only these but also the most thick-billed genera were decidedly Drepanid, that Dr Sclater's views became known to me.

The explanation is very simple: the Oo (*Acrulocercus*) freshly killed or alive[1] has no such odour. The specimens supposed to possess it had no doubt been enclosed in boxes with Drepanids, or when collected in the field had been placed in a bag with them, and had thus become impregnated with their odour.

This odour, as I have pointed out in my former notes, cannot be acquired from the food, because it it found in forms of such diverse habits—*e.g.* in *Drepanorhamphus* at times when it is feeding solely on the nectar of flowers, in weevil-eating *Heterorhynchus*, in *Psittacirostra* when it is devouring the red fruit of *Freycinetia*, in *Chloridops* when the sole contents of the crop are the seeds of the bastard sandal. Neither of the Meliphagine birds nor the Flycatchers, when feeding in the same trees and on the same food as Drepanids, possess any such smell All these facts point to the odour as being an ancestral character in the Drepanididae.

In this connexion it may further be remarked that the song of the thick-billed *Pseudonestor* is practically identical with that of the various species of *Heterorhynchus*, which have always been allowed to be Drepanids, and that *Telespiza*, living isolated on the island of Laysan hundreds of miles distant from its allies, has a song similar to this. I shall not easily forget my astonishment when I first heard it on passing a house in Honolulu, and found on enquiry, not the expected *Heterorhynchus*, but *Telespiza*! Possibly the latter may have other notes, but the fact remains that the song I heard was note for note the same as that of the former species, and I heard it repeatedly.

7. Cause of Frugivorous Habits in the Thick-billed Drepanididae.

The thick-billed frugivorous Drepanids, like the purely or almost purely insectivorous members of the family, have no doubt assumed their frugivorous habits for the same reason that the latter have become insectivorous, viz., the competition for food, rendered unusually keen from the exceptionally small area of distribution. The development of the beak and the loss of the elaborate sucking-tongue have naturally followed. In this connection it is interesting to note that the rather strong-billed *Chlorodrepanis stejnegeri* of Kauai, so far as I know, stands alone amongst the brush-tongued forms in feeding freely on fruits; for at certain seasons it voraciously devours the berries of the poisonous *Wikstroemia*, in the same manner as *Phaeornis*. Such a species—becoming more and more frugivorous and abandoning flowers for fruits—may be considered as potentially the ancestor of a new series of thick-billed forms; at present it is largely a honey-sucker, largely insectivorous, and on occasion largely frugivorous. A line may be traced among the thick-billed forms through the purely insectivorous *Pseudonestor* to the largely frugivorous, but still largely insectivorous, *Psittacirostra*, to end in *Chloridops*, which has become almost entirely frugivorous.

[1] The writer has on more than one occasion had *A. nobilis* alive.

8. Distribution of Genera in the Islands.

The distribution of the genera within the group is very unequal, only five of the eighteen having a range which covers all the islands that are forest-clad. These are *Vestiaria*, *Himatione*, *Chlorodrepanis*, *Oreomyza*, and *Psittacirostra*. Three others, *Hemignathus*, *Heterorhynchus*, and *Loxops*, are found on four islands, a species of each inhabiting Kauai and a second Hawaii, the two extreme forest-bearing islands of the Archipelago. One, *Palmeria*, inhabits only Maui and the neighbouring island of Molokai. *Drepanorhamphus* is peculiar to Molokai, *Pseudonestor* to Maui, *Telespiza* to distant Laysan. Hawaii has no less than six genera peculiar to itself—*Drepanis*, *Ciridops*, *Viridonia*, *Loxioides*, *Rhodacanthis*, and *Chloridops*.

9. Distribution of Species.

The distribution of the species is fully given in the table (p. 390). One form, *Heterorhynchus lucidus*, is almost certainly extinct, while several others, if not extinct, are so extremely rare as to be very nearly so. On examining the table of distribution it is at once noticeable that the birds may be divided into two very strongly contrasted classes. Thus *Oreomyza* is represented by a distinct species on each of six islands, as are also *Hemignathus*, *Heterorhynchus*, and *Loxops* on each of four. On the other hand, *Himatione*, *Vestiaria*, and *Psittacirostra* range over the whole main group, each with a single unmodified species. *Chlorodrepanis* occupies an intermediate position with two very distinct forms on Kauai, and another form, sometimes considered divisible into three or more species, ranging over the remaining islands. Of these, however, the distinguishing characters are so slight that it is questionable whether they are worthy even of subspecific rank, and in any case such characters are by no means to be considered equivalent to those which separate the different species of *Oreomyza*. The latter are clearly the results of isolation, one island having been colonized by a species from another, which has subsequently acquired peculiar characters. It might be supposed that the birds in the other class, which shew no change on the various islands, are in some way less susceptible to the effects of isolation and change of environment. Probably this is not the case, and the true explanation is to be found in considering the habits of the members of the different genera.

Himatione, *Vestiaria*, and *Psittacirostra* are all birds which take extensive flights, often at a great height in the air, and frequently form small companies in these flights. If we stand on the main ridge of some of the islands the birds may be seen passing high overhead from leeward to windward or vice versâ. All freely traverse open country, in passing from one feeding-ground to another. Consequently when storms arise they are extremely likely to be carried across the channels between the islands, and no doubt

Table of the Distribution of the Species of the Drepanididae.

	Hawaii.	Maui.	Molokai.	Lanai.	Oahu.	Kauai.	Laysan.
Drepanis	*pacifica*						
Drephanorhamphus	.....	.....	*funereus*				
Vestiaria	*coccinea*	*coccinea*	*coccinea*	*coccinea*	*coccinea*	*coccinea*	
Palmeria	.....	*dolii*	*dolii*				
Himatione	*sanguinea*	*sanguinea*	*sanguinea*	*sanguinea*	*sanguinea*	*sanguinea*	*freethi*
Ciridops	*anna*						
Hemignathus	*obscurus*	.....	.....	*lanaiensis*	*ellisianus*	*procerus*	
Heterorhynchus ...	*wilsoni*	*affinis*	.....	.....	*lucidus*	*hanapepe*	
Pseudonestor	.....	*xanthophrys*					
Viridonia.....	*sagittirostris*						
Chlorodrepanis ...	*virens*	*virens*, var.	*virens*, var.	*virens*, var.	*virens*, var.	*parva* and *stejnegeri*	
Loxops.....	*coccinea*	*ochracea*	.....	.....	*rufa*	*caeruleirostris*	
Oreomyza.....	*mana*	*newtoni*	*flammea*	*montana*	*maculata*	*bairdi*	
Psittacirostra	*psittacea*	*psittacea*	*psittacea*	*psittacea*	*psittacea*	*psittacea*	
Loxioides.....	*bailleui*						
Telespiza	.....	.....	.....	.....	.....	.....	*cantans*
Rhodacanthis	*palmeri* and *flaviceps*						
Chloridops	*kona*						

this often happens. The birds of the other class, such as *Hemignathus*, *Oreomyza*, *Heterorhynchus*, &c., do not take these extensive flights, but keep closely to the forest, very rarely—and most of them never—venturing into the open. Very seldom would they be likely to get blown across from one island to another. In short there is little doubt but that individuals of *Vestiaria* and its class are transferred from one island to another sufficiently often to prevent any true isolation, which is not the case with the other class. Who can fail to believe that a *Loxops* or a *Hemignathus* would have prospered on Molokai had they ever reached that island? Although *Himatione* ranges unchanged over six islands, yet after, by some remote chance, reaching the very distant Laysan it has there developed into a distinct form; and the case of the two extreme

forms of *Chlorodrepanis* on the rather distant island of Kauai is also greatly in favour of my hypothesis.

That any of the Drepanid birds cross even the narrowest channels between the islands *willingly* is not to be thought of. In times of storm they are often blown down to the lowlands, sometimes in considerable numbers, in which case they mostly fail to regain the forest and perish after a few days. The only birds that I have myself picked up dead (sometimes in numbers) on the coast after these storms are of the genera *Vestiaria*, *Himatione*, and *Psittacirostra*; in fact, the very forms which by their habits are most liable to be carried away by the wind. Further, it is well known that, after stormy weather, the two former sometimes reach the bare island of Niihau, across the considerable channel which separates it from Kauai, but they cannot live there long on account of its unsuitable nature. No doubt the majority of these unwilling emigrants perish, but it is certain that those blown from a high elevation on one island must not infrequently land in suitable forest-country on one of the others.

There is however another possible explanation of the general distribution over all the islands of the single unmodified species of each of the three genera, *Himatione*, *Vestiaria*, and *Psittacirostra*. The plumage of all these was used by the natives in their feather-work, and the birds themselves were frequently kept alive in captivity to serve as decoys. It might therefore be contended that the bird-catchers established these species on those islands from which they were originally absent. Opposed to this theory are the facts already given, and especially the fact that the red birds are known in time of storms to be occasionally transported from Kauai to Niihau, across a channel not much less formidable than any of the other channels, excepting that between Oahu and Kauai, and wider than some of the others. Moreover had the natives been in the habit of making such transportations one can hardly doubt that they would have established the Mamo (*Drepanis*) on other of the islands, since it could easily be kept alive in captivity. One can only wonder that this was not done, if not in the earlier times, at least at a later period when the whole group was under one sovereignty.

10. Richness of the Island of Hawaii in peculiar Forms.

The relative richness in birds of Hawaii, with its eleven peculiar species and no less than six peculiar genera, is manifest and interesting, since in other groups of animals with highly peculiar species it is frequently (though not invariably) extremely poor, as compared with the older islands of the group. Probably its large area and very varying climate has favoured the multiplication of peculiar forms, while it must not be forgotten that, owing to its position at the end of the group of islands, it is incapable of sending forth emigrants except in one direction. That this is of importance is rendered more likely from a consideration of the Drepanids of Kauai, at the other end of the group of forest-clad islands. Kauai, it is true, has no peculiar generic forms, although

geologically so much more ancient than the large island; but being the most distant of the group, as well as at one extremity of the series of islands, its two species of *Chlorodrepanis* are by far the most isolated, its *Hemignathus* and *Loxops* are similarly circumstanced, while in the Meliphagines its *Acrulocercus* is very different to the other forms, which are closely allied inter se, and in the Turdidae it has the two extreme forms of *Phaeornis*. No doubt its small area and comparatively constant climate tend to render it much less rich in Drepanids than Hawaii.

11. Extreme Specialization of many Forms of Drepanid Birds.

If, as is natural, we consider the primitive form of Drepanid to have been structurally very similar to such birds as are now comprised in the genera *Himatione* and *Chlorodrepanis*, and side by side with these place such forms as *Loxops*, *Drepanorhamphus*, *Heterorhynchus*, and *Chloridops*, the remarkable specialization of the latter is at once apparent, though we are still able to examine connecting forms. To me this specialization indicates the severe competition that has taken place between the Drepanids in past ages. When a vast portion of the food-supply was derived from the blossoms of flowers, and this source of food, as I have shown, was relatively small to what it became later, change to a purely insectivorous, or largely frugivorous, diet must have been very advantageous to the individuals concerned, and the greater the specialization which resulted in obtaining some particular food (provided that it was sufficiently abundant), the greater the advantage to the species. To the field-naturalist who has examined many specimens of such a form as *Pseudonestor* at various seasons and found that its food consists essentially of the larvae of a group of longicorn beetles peculiarly Hawaiian, and not less remarkable than the Drepanids themselves; who has seen how perfectly modified it is for obtaining these; how perfectly adapted is the bill of such a form as *Drepanorhamphus* for obtaining the nectar from the deep tubes of the giant-blossomed Lobeliaceae, inaccessible to other birds; how wonderful is the form of *Heterorhynchus*, which delights in the hard boring weevils, themselves equally noticeable; how powerful are the muscles of the head and beak of *Chloridops*, which can crack the stones of the ripe fruit of the bastard sandal; the extraordinary advantage of this specialization in each form for acquiring a constant supply of food almost or quite inaccessible to its allies, and that too in a country where the small land-area may be supposed to have rendered competition unusually keen, must appeal with the greatest force.

12. High Specialization may become a Source of great Danger.

This high degree of specialization, although of the greatest benefit under stable conditions, with a change of these obviously becomes a source of great danger. Thus, destroy the special food-supply of the birds mentioned above, and there is little doubt

but that most of them would very quickly become extinct; for forms so perfectly adapted for special ends are, under ordinary circumstances, but ill-adapted to change their mode of life; and it is amongst such forms that most of the rarest species are found, while a considerable number of them already verge on extinction. It is probable that this state of things has largely been brought about by man, and in particular by the destruction of the lowest forest. Even now, in winter storms, large numbers of birds resort to the lowest skirts of the existing forest, generally at an elevation of 1200—1500 feet; and it is well known that in Cook's time such forms as *Psittacirostra*, *Himatione*, and *Chlorodrepanis* actually came down to the coast in Kealakeakua Bay, though now such flights would mean death to the visitants. Moreover, at these lower altitudes the flowering-season of most plants is different from that in the uplands, and they must have been an important source of food at seasons when it was scarce elsewhere.

13. Other causes of extinction of Hawaiian Birds.

Although the destruction of the lowest belt of forest over by far the greater part of the islands has, in my opinion, been a most efficient cause of the destruction of native birds, many other causes have been at work, all of which are due to the occupation of the islands by white men. Such causes are the introduction of cattle and goats, which have extirpated or very much thinned out great portions of the native forest; of cats, foreign rats, and the mongoose (which are direct enemies), as well as of the mynah, which not only attacks and drives away other birds, but also devours their eggs and young. The disturbance caused by the entrance of cattle into untrodden forest appears to be alone sufficient to scare away some species. Thus, on a very rough lava-flow on Hawaii in 1892, the "Oo" (*Acrulocercus nobilis*) was very numerous, and as many as a dozen of these birds could be seen in a single tree, making, with hosts of the scarlet "Iiwi," the crimson "Apapane," and other birds, a picture never to be forgotten. A few years afterwards, on revisiting the spot at the same season, although the trees were, as before, one mass of flowers, hardly a single "Oo" was to be seen. The only noticeable change was that cattle were wandering over the flow and beginning to destroy the brushwood, just as they had already reduced the formerly dense forest bordering the flow to the condition of open park-land.

Cats were introduced into the Hawaiian Islands at a very early time, and, no doubt, increased excessively, while, as their owners moved from place to place, many strayed into the woods and began to feed on mice, rats, and birds. They are now found wild on all the islands, apparently only the wettest portions of the forest being free from them. On Lanai, in walking up a single ravine, I counted the remains of no less than twenty-two native birds killed by cats, and these must all have been destroyed within two days, as previously the whole gulch had been washed out by a heavy flood. Two cats were actually shot on this occasion as they were devouring their prey, and several others seen,

but, owing to the fact that they are extremely shy and mostly nocturnal in habits, few people who have not lived much in the woods have any idea of their numbers. The common rat is also quite at home in the forests and is decidedly arboreal in habits, feeding on fruits, land-molluscs, and no doubt on birds. The mynah, which I have myself seen devouring both young and eggs of other species, has increased prodigiously, and probably exceeds in numbers the whole of the native land-birds put together. It has greatly extended its range through the forest since 1892, and on some of the islands is now ubiquitous.

14. Songs of Drepanid Birds.

None of the Drepanids can be considered first-class songsters. The "Ou" (*Psittacirostra*) and the "Palila" (*Loxioides*) are, when at their best, distinctly pleasing, and surpass all the others. The "Akialoas," especially *Heterorhynchus*, have a song full of vigour, yet not beautiful or sustained but always delightful to hear, as being an expression of the highest contentment. This energetic outpouring of melody is noticeable likewise in *Pseudonestor*, *Hemignathus*, and *Chlorodrepanis*, the songs of all of which, as also those of *Loxops* and *Oreomyza* (when it does sing), bear a general similarity to one another. *Pseudonestor* and *Heterorhynchus* have an identical song; that of *Viridonia* is the same as that of *Chlorodrepanis*, with two or three notes added at the end. *Rhodacanthis* whistles several notes, which to anyone walking through the woods might appear to be rather the utterance of a man than of a bird. The songs of the other group of Drepanids are quite different. That of the "Iiwi" (*Vestiaria*) is harsh in the extreme. The song of the "Apapane" is short, monotonous, and often repeated, but not unpleasing. It has a singularly plaintive call-note. The "Mamo" (*Drepanis*) and the allied form on Molokai have an identical cry, except that in the latter at its best it is probably much louder. The song of *Palmeria* is peculiar, as it makes a remarkable vibrating or gurgling sound. In spite of the dissimilarity in the normal songs or cries of the birds of this section, most of the different forms frequently utter calls or notes very similar to one another. They are more varied than the almost universal squeak of the call or alarm-note of the green-feathered section.

15. Native names of Hawaiian Drepanididae and some other birds.

The native names of the forest-birds are themselves of some interest, showing as they sometimes do the rudiments, as it were, of a crude, and often erroneous, classification. The names are certainly very aptly chosen, and their meaning is in most cases apparent to anyone with some knowledge of the language. They may be divided into several classes.

(1) Names given from peculiarities of structure or plumage, e.g. Akihialoa (*Hemignathus*) from its long, sharply-pointed beak; Nukupuu (*Heterorhynchus*) from its

hill-like (i.e. strongly rounded) bill; Palila from its aberrant *grey* plumage. Such names are often compounded with a- beak (lit. jaw) e.g. Akekee, Amakihi, Akohekohe.

(2) Onomatopoeic names, e.g. Alala (*Corvus*), Elepaio (*Chasiempis*), and Oo (*Moho* or *Acrulocercus*). Such names may have an applicable meaning as well as imitating the cry of the bird, e.g. Kioëa (*Numenius*), which is onomatopoeic and at the same time refers to the height at which the bird stands from the ground.

(3) Names derived from the nature of the sounds uttered by the bird, e.g. Apapane (*Himatione*), Akikeke (*Oreomyza bairdi*), Kakawahie (*O. flammea*), &c.

(4) Called after a person, Amaui (*Phaeornis*) Maui's bird.

(5) After colour of plumage and habits, Ula-ai-hawane (*Ciridops*), the red bird that feeds on the hawane (*Pritchardia*).

Some names appear to have been used as we should say generically, e.g. Iiwi (written also Iwi and Iawi), which was not only applied to the *Vestiaria* but certainly on Kauai and Oahu to the long-billed *Hemignathus*. Probably Iwi was originally a general name for the birds with long curved beaks other than those with largely black plumage which belonged to the genus Oo. So we have Iiwi polena, Iiwi popolo, and other names for *Vestiaria* in its various phases of plumage, such forms being considered distinct species by the natives. The name of 'Oo' seems similarly to have been applied to all the black honey-sucking species, for there is no reason to doubt the correctness of Cook's naturalists, who give the native name 'Hoohoo' for the Mamo, seeing that they, like the other early visiting naturalists, are invariably correct in the names given to the more obscure birds, although their spelling is frequently grotesque. Probably the full name was originally Oo mamo just as we have the Oo-aa, dwarf Oo, of Kauai, and the Oo-nukuumu, Oo with sucking-beak, of Molokai (*Drepanorhamphus*).

I may add that in the native names applied to the birds in this work I have in all possible cases adopted the spelling used in Andrews's Hawaiian Dictionary (1865), as often preferable to that used in recent ornithological works; and where names given by living natives do not agree with those given by the older natives to naturalists who visited these islands in the first half of last century I have invariably adopted the latter, the more recent names being often obviously corruptions of the older.

The subjoined list will enable anyone to distinguish at a glance the various genera of Drepanididae. More characters are frequently given there than are necessary for merely separating the different forms, especially where these characters appear to me to be of great importance. It is only necessary to add that the views expressed in these remarks on the Drepanid birds have not been formed off-hand, but are the results of much study and observation, extending over a period of ten years, six of which have been spent in the islands themselves, for the most part in the haunts of the various species. As the writer has had the opportunity of seeing many of the rarest forms—not a few individuals only, but scores or hundreds—he has had ample opportunity for

careful study of the habits, without the need or desire to kill a valuable specimen whenever seen. For this reason the biological considerations may be held to be of more importance than would be the case were they based on a more superficial study extending over a short period of field-work.

Table of genera of Drepanididae.

1. (2) Apices of some of the primaries truncate, *or* if not truncate, then the front of the head bearing a large crest of narrow curved feathers, which overhangs the base of the beak.
   Plumage of upper parts always partly black, the rectrices always black (sometimes white-tipped), the wings always at least largely so.
   White markings always present in the adult, either on the wings or upper parts of the body, at times confined to the outer web of some of the primaries.
   Young birds with body-feathers always of a black or dark obscure colour, either wholly or in part; when with many pale feathers (*Vestiaria*), then these are spotted with black ..... DIVISION I.
2. (1) Apices of primaries never truncate; head never with a crest of narrow curved feathers.
   Plumage of adults never in the least black above, not even the tail black.
   Young birds never clothed with black or dark obscure plumage, nor black-spotted, but always largely green or olivaceous ..... DIVISION II.

DIVISION I.

1. (6) Beak very long and strongly curved, as long as or longer than the metatarsus.
2. (5) Beak black, wholly or in great part; plumage mainly black or black and yellow. Feathers of throat not modified.
3. (4) Plumage black and yellow; nasal opercula not very long ..... *Drepanis.*
4. (3) Plumage not at all yellow; nasal opercula very much elongated ..... *Drepanorhamphus.*
5. (2) Beak entirely pale; plumage of adult scarlet, of young yellowish and black-spotted; feathers of throat much modified, narrow, and stiff ..... *Vestiaria.*
6. (1) Beak never very long, straight or but little curved.
7. (8) A large crest of pale feathers curving over the base of the beak..... *Palmeria.*
8. (7) Head without a crest.
9. (10) Beak moderately long, sharply pointed; body-plumage not variegated with strongly contrasted colours ..... *Himatione.*
10. (9) Beak rather Finch-like; body-plumage highly variegated ..... *Ciridops.*

DIVISION II.

1. (4) Beak extremely long and one or both of the mandibles strongly curved, the upper one always so and very slender and delicate at its apical portion—so slender as often to be even slightly flexible.
2. (3) Upper mandible only a little longer than the lower, nasal setae altogether wanting ..... *Hemignathus.*
3. (2) Upper mandible greatly exceeding the lower (by from $\frac{1}{2}$ to $\frac{1}{3}$ its own length), nasal setae well developed..... *Heterorhynchus.*
4. (1) Beak not of extraordinary length and much curved; if moderately long and curved, then the apical portion of the upper mandible not extremely slender and very little longer than the lower.

5. (14) Beak never of very robust form, like that of a Grosbeak, nor of heavy build, with the upper mandible conspicuously surpassing the lower; if (as in *Loxops*) the beak is short and like that of a small Finch, then the lower mandible is more or less distorted either to the right or left, the tail is elongated and conspicuously forked, and the birds themselves are of very small size.

6. (13) Tail more or less short, not long and distinctly forked; lower mandible not deflected; beak not short and robust, like that of a small Finch.

7. (8) Beak straight, long, and strong, about as long as the metatarsus. (No well-marked sexual distinctions in plumage of adults. Tongue long, brush-like, typically Drepanid.).....*Viridonia.* L. sag.

8. (7) Beak curved or straight, if straight then much shorter than in 7.

9. (10) Beak more or less curved, generally distinctly so; nasal setae always present and well developed. Tongue typically Drepanid, long, and brush-like. (Well-marked sexual distinctions in plumage of adult, the male much brighter in colour.) .....*Chlorodrepanis.* L. virens, L. parva

10. (9) Beak straight or not curved as in 9; distinct nasal setae or setiform feathers may be present or entirely wanting. Tongue abnormal, flattish, slightly cleft at the apex, not of the typical tubular brush-like form.

11. (12) Nasal setae or modified setiform feathers well developed, so as to be able to shield the whole length of the nasal openings. (Colour of sexes little differentiated.).....*Oreomyza.*

12. (11) Nasal setae or setiform feathers entirely absent, or at least very short and little developed, not able to shield the nasal openings. (Sexual coloration of adults markedly different.) .....*Paroreomyza*[1], subgen. nov.: type *Oreomyza maculata.* L. maculata

13. (6) Tail elongated, distinctly forked at apex; lower mandible more or less deflected; beak short, but stout, like that of a small Finch. (Tongue typically Drepanid.) .....*Loxops.* L. coccinea

14. (5) Beak always strong, often excessively powerful and heavy, sometimes with the upper mandible conspicuously surpassing the lower. Robust birds, never very small.

15. (18) Beak with the upper mandible greatly or very greatly surpassing the lower in length, never very broad towards the base in dorsal aspect, more or less and sometimes very strongly compressed laterally. Body above with green plumage.

16. (17) Upper mandible very strongly flattened, or compressed laterally, and high. Tail very short, as in *Heterorhynchus*. Coloration of adults nearly similar in both sexes, each with only a yellow superciliary line on head. (Tongue not typically Drepanid, but more so than that of *Oreomyza*, rather elongated.) .....*Pseudonestor.*

17. (16) Upper mandible not very strongly compressed laterally, subcariniform. Tail not extremely short. Colour of adults dissimilar in the two sexes, the male with crown of head bright yellow. (Tongue degraded from the typical honey-sucking organ, but Drepanid characters still distinguishable.) *Psittacirostra.* P.

18. (15) Beak with upper mandible only slightly (though distinctly) surpassing the lower in length and more swollen laterally, often very much so, so that in most forms the nasal openings appear to be quite dorsally placed and the beak very broadly rounded above. Colour of plumage of body above not always green.

[1] Herein I place also the other three species with sexual dimorphism.

19. (20) Beak strong, but not excessively powerful and heavy, much less so than in the following. Plumage of body above ashy grey in adults. Colour of sexes a little different, the yellow of the head in female less bright .....*Loxioides.*
20. (19) Beak excessively heavy and powerful. Plumage of body above not ashy grey.
21. (24) Upper mandible in dorsal aspect of very elongate triangular form. Upper and lower mandibles well adapted to one another. Male at least with the plumage of the head contrasting in colour with that of the upper parts of the body.
22. (23) Beak with cutting-edge of lower mandible distinctly and evenly curved on the apical part. Immature birds without dark spots above. (Very great differences in colour between the sexes when adult, the female remaining much like the young of either sex.).....*Rhodacanthis.*
23. (22) Beak with cutting-edge of lower mandible not distinctly and evenly curved. Immature birds with dark spots .....*Telespiza.*
24. (21) Upper mandible in dorsal aspect with the sides not very strongly convergent to the apex, so as to form a very elongate triangle. Cutting-edges of mandibles irregular, so that they are not perfectly adapted to one another. Plumage of head in neither sex conspicuously different from that of the body above. (No marked difference in colour of sexes.).....*Chloridops.*

The list of genera given above calls for a few remarks. In the first division the position of the abnormal *Ciridops* appears to me quite certain. Its characteristic black wings and tail, and the presence of white (not quite clear white) feathers, its scarlet plumage, to my mind so extremely like that of *Vestiaria*, and the blackish-grey feathers of the throat, so similar to what may be seen in *Palmeria*, leave no question as to its affinities. In the second division the ashy plumage of *Loxioides* appears aberrant at first sight, but it is noteworthy that others of the "green" section pass through a phase of plumage very similar to this (e.g. certain species of *Loxops*, &c.), which shows how easily it may have been acquired. *Telespiza* in the dark-spotted plumage of the young is also aberrant, but this condition does not appear to me comparable with the dark or black-spotted plumage of the first division. Its position in the second or green section is obvious, and *Rhodacanthis* might well be united with it generically.

Drepanis Temm.

Native name *Mamo.*

The only representative of this genus is the celebrated Mamo whose plumage supplied the material for the choicest of that feather-work for which the Hawaiian Islands have always been famous. The Mamo is now a very rare bird and it is quite possible that any year may be the last of its existence. Formerly it was without doubt of wide range over the island of Hawaii since it is known to have occurred both in the leeward and windward forests as well as in the Kohala Mountains. Unlike the Oo, which after the yellow axillary feathers were plucked out, could be, and sometimes was, liberated practically uninjured, the Mamo entirely denuded of its yellow feathers would have been in a sad plight, and would almost certainly have succumbed to such rough

usage. It is quite certain that up to about 20 years ago these birds still existed in some numbers in the forests of Hilo district, for at the time of the great lava-flow of 1880 a considerable number were shot for the sake of the yellow feathers, as many as twelve having been obtained by a native bird-hunter in a single day. None of these were preserved as entire skins, the yellow feathers alone being saved.

That the Mamo is now extremely rare is certain, for Mr W. H. Henshaw, the expert American ornithologist, has not up to the present time obtained a single example, although he has resided only a few miles from a noted and perhaps now the only locality for this bird, whence was obtained the only specimen procured of late years.

Very little is known as to the habits of the Mamo, and the accounts that have been handed down, and the information one can glean from the few existing natives who have seen it, do not always agree. Some speak of it as very tame, others as wild and shy, but the latter account seems generally to refer to localities where, and to a time when, it was systematically hunted. All agree as to its fondness for the nectar of the arborescent lobelias, and it was at the blossoms of these that it was usually captured. Like the allied form on Molokai it seems to have cared little for the Ohia flowers when the lobelias were in bloom. Emerson says that it was also partial to the flowers of the native fan-palms (*Pritchardia*) when in blossom, and I have myself been informed that it habitually frequented these in company with the Ula-ai-hawane (*Ciridops*). A fortunate collector if he could visit at frequent intervals the clumps of these in the heart of the dense forests and far removed from any house (and there are many such groves) might yet obtain both these rarities at one stroke. We are also told by the above-named writer that the bird devoured the ripe red fruit of the Ieie, but I suspect that this may be an error from confusion with the Oo, which is well known to be partial to that food in some localities.

The call of the Mamo is a single, rather long and plaintive note, as imitated by natives who have been familiar with it, and is so generally similar to that of its relative of Molokai, as to leave no doubt as to the correctness of these imitations. It would readily respond to this call, which was regularly used to attract it to the hunter's snare.

As the Mamo was the greatest prize of the ancient bird-catcher, a short account of the different modes of procedure adopted in catching it and other forest birds may be included here. An excellent article[1] by Dr N. B. Emerson on this subject can be found in the Hawaiian Annual for 1895. The first of these methods was by the use of bird-lime, in the employment of which a special apparatus was generally used. This consisted of a long, slender, polished pole (kia-manu), made sometimes of Kauila wood (*Alphitonia*) or of Ulei (*Osteomeles*). At the end of this were fixed three distinct parts, (1) a recurved hook (kihele), by which the apparatus was hung to the tree, (2) a straight cross-bar (kano), and (3) a forked branch continuing the pole (lalua). The manner of dressing the kia-manu varied however in details. Those parts on which the

[1] The following account is largely taken from this article.

birds would alight were well smeared with bird-lime. This apparatus was used either bare, or it was baited with choice flowers, or with a decoy-bird (maunu), generally the scarlet Iiwi or crimson Apapane, fastened to the prong at the tip of the pole. This bird acted either as an attraction to others of its own species, or to different kinds of birds, especially to the Oo, which would come to attack and drive it from its perch, and itself get caught The habit that several kinds of birds have of alighting on a bare branch, when about to sing, especially on such as project above the foliage of a tree, no doubt allowed numbers to be caught on the bare pole without the use of bait; the more so as natives, who are acquainted with the forest birds, can imitate their call notes in the most perfect manner. The decoy-birds, always honey-suckers, were often kept alive in cages, being easily fed on the nectar of flowers and the juice of sugar-cane, and are said to have become quite tame in confinement. The bird-lime was obtained from several kinds of trees, especially the Papala (*Pisonia*), the Haha or Oha-wai (arborescent lobeliaceae), the Ulu (Breadfruit), and the Koko (*Euphorbia*). The second method was by means of a noose at the end of a fine line made of Olona fibre (*Touchardia*), the snare being so placed that the bird was caught when visiting the bait of flowers, the hunter lying concealed at a distance and pulling the string at the right moment. This appears to have been the chief method employed in catching the Mamo, which was first attracted by an imitation of its call note. In some such way as this, I believe, the specimen obtained in recent years by Mr Rothschild's collectors was caught alive by a native. The third method was the simplest of all. The hunter simply covered himself with branches of bushes bearing tubular flowers, and holding up one of these between the finger and thumb, as soon as a bird inserted its beak into the blossom, grasped this tightly and pulled it down under the leafy covering. This is the method which the naturalist Townsend observed as practised by the native boys on the island of Kauai in 1835. "In this way," he says, "dozens of beautiful birds are taken, and they are brought to us living and uninjured." As the feathers of the native birds were a perquisite of the chief, and not to be worn by the common herd, the former had his own professional bird-catchers, who are said to have been trained in this art from early youth. The Iiwi (*Vestiaria*) and Apapane (*Himatione*) furnished scarlet and crimson feathers, the Ou (*Psittacirostra*) and Amakihi (*Chlorodrepanis*) green, the Mamo (*Drepanis*) yellow, and the Meliphagine Oo (*Acrulocercus*) this colour and black. Of the forest birds no other species appear to have been utilized to any considerable extent, not probably because they would not have been acceptable, but because on account of their habits it would have been impossible to catch them in sufficient numbers by such means as were known to the native bird-hunter. All those that were utilized could readily be caught by a bait of flowers, excepting perhaps the Ou, and this bird probably not less easily on account of its fondness for the ripe Ieie, and its frequent habit of alighting to sing on a bare projecting branch of a tree otherwise well-covered. An excellent account of the feather-work itself is contained in the "Memoirs of the

B. P. Bishop Museum" (Vol. I. Pt. 1), written by Mr W. T. Brigham, the director of that institution.

(1) *Drepanis pacifica* Gmel.

HAB. Hawaii, formerly widely distributed; of late years very rare and only taken in the Hilo district.

DREPANORHAMPHUS Rothsch.[1]

Native name *Oo-nuku-umu.*

Like the preceding genus this closely allied form is also monotypic, and occupies on Molokai the place of the Mamo on Hawaii. From what we know of the habits of the latter the two forms closely resemble each other in these, as well as in their cries. The Oo-nuku-umu is one of the rarer island birds and is now confined to the higher parts of the forest on Molokai, where the ground is soft and boggy. At the time when I discovered it these woods were in an absolutely natural condition, but since that time both cattle and deer have run through them and they are in most parts much less dense and less wet than they were in 1893. The bird is essentially one of the underbrush, and I never saw it alight high up in a large tree, and only very rarely was it seen at more than twelve feet from the ground. It is a true honey-sucker, and not one of those obtained by me contained animal food. In my earlier notes I supposed it to be insectivorous from the fact that I saw it exploring beneath the wet moss, which covered the tree trunks, with beak and tongue. However a specimen subsequently obtained after it had been watched at this pursuit for some minutes proved on dissection to contain no trace of insect food, and that the adult or the young after they have left the nest are insectivorous is not yet proved. As the moss coating the trees was invariably soaked with water it may be that this only was the object of its search, the more so as insects in this situation were always very scarce. No doubt nestlings will be found to be fed on caterpillars, as is customary with the other honey-sucking Drepanids, but the youngest specimens seen, which were probably about a month from the nest, entirely confined their attention to the nectar of flowers. When investigating the wet moss the tongue is darted in and out with great rapidity so as to appear like a liquid streak, the eye not being able to distinguish each separate movement. On one occasion only was the bird seen to visit the red flowers of the Ohia; the crimson Apapane (*Himatione*), the Akohekohe (*Palmeria*), and the Oo (*Acrulocercus*) being present with it in the same small bushy tree. With that pugnacity which is said to be equally characteristic of the Mamo, it continually drove the smaller red birds from the bush, to be itself in turn driven off by the superior strength of the Oo, but always returning after a few moments to the same flowers. Excepting the above instances,

[1] The validity of this genus is doubtful. This explains the omission of it from the diagram of pedigree on p. 408. EDITOR.

the Oo-nuku-umu entirely confined its attention to the large tubular flowers of certain arborescent lobelias. On one occasion, when engaged in entomological work, I saw three adult males of this bird in one low bush passing from flower to flower and spending only a few seconds over each. These were very tame, and I was able to watch their movements in this and neighbouring bushes for at least an hour. Even those flowers which were at a height of not more than a foot from the ground were carefully explored. The crown of the head of each of these birds was plentifully encrusted, as indeed is usually the case, with the sticky white or purplish-white pollen of the lobelias and gave them a singular appearance. Of all that I ever saw the first two specimens alone were really timid, but at that time I was proceeding carelessly and with much noise, cutting a path as I advanced. More usually they readily approach and even follow the collector, or alight on a branch at a distance of only a yard or two, moving occasionally from place to place and turning the head this way and that to make a thorough scrutiny. For this reason they are sometimes even difficult to shoot, as they keep following the collector as he retires to a suitable distance for a shot, and when they fly off at last it is for good and all. Sometimes when they have satisfied their curiosity they will sit quietly preening their feathers, when they have a very comical appearance, much stretching of the neck being necessary to enable them to reach the fore parts of the body with the tip of their long beaks; at other times they will proceed to feed quietly on the flowers of a neighbouring bush. They readily respond to an imitation of their call note, which much resembles that of the Mamo, but sometimes they utter a loud cry of extraordinary clearness, repeated at short intervals, such as I have never heard imitated by the old natives, who well knew the call of the latter. No doubt this loud cry takes the place of a true song and differs rather in degree than kind from the more gentle call note. The Oo-nuku-umu would appear to be the rarest of all the birds of which I obtained specimens. On one occasion when not prepared to collect birds I saw seven individuals in a single day, but this was quite exceptional, and when wanting a specimen I have spent a whole day or several days in its haunts, and in exclusive search for it, without seeing even a single one, and this at a time when I had become perfectly familiar with its habits.

(1) *Drepanorhamphus funereus* (Newton).

HAB. Molokai, in the higher forest and not common.

VESTIARIA Fleming.

Native name *Iiwi* (*Iwi* and *Iawi*).

The 'Iiwi' is one of the most abundant and generally distributed of all the Drepanid birds, being found throughout the woods of all the forest-clad islands. On Oahu, however, it is now less abundant than on the other islands, but it still exists even in the mountains in the immediate vicinity of Honolulu, although rare. Further away from the city it is common enough in both the mountain ranges. The general scarcity

of birds on Oahu as compared with the other islands is noticeable, both as to the number of species and individuals, but this scarcity applies only to recent years, for the well-known ornithologist Townsend expressly states that he found birds more abundant on Oahu than on Kauai, some 65 years ago. On all the other islands the Iiwi was found to be very common from the lower forest up to the highest elevations reached by forest birds, even at those which during the summer months are subject to frequent frosts and at which in the winter the cold is really severe.

The Iiwi is a more powerful flier or at least takes longer continuous flights than most of the Drepanididae, and as its food-supply becomes deficient in one locality it readily migrates to another. In most localities there is however at all seasons a resident population, since all do not depart when these migrations take place. Some parts of the forest, absolutely devoid of native birds at most seasons, are regularly visited by the Iiwi at special times. Thus in some of the valleys of Oahu the mountain apple (*Eugenia*) forms extensive groves, below the ordinary range of forest birds. For a brief period each season numbers of the Iiwi visit the blooms of these trees, and after these fail are seen no more in the neighbourhood until the next flowering season. In the higher forests of the more lofty mountains large numbers are added to the usual stock of residents during the flowering season of the yellow-blossomed Mamani trees (*Sophora*). In the lower forests of middle Kona many thousands of these birds could be seen in a very small area when the great Ohia trees were covered with flowers. On the nectar of these and many others the Iiwi habitually feeds, and is extremely partial to many of the native campanulate or tubular flowers, the arborescent lobelias, the bananas, some labiates, as *Phyllostegia*, the Nukuiiwi (*Strongylodon*), so called from the resemblance of its flowers to the beak of this bird, and many others. Nor does it despise garden flowers which the settlers have brought from other countries, sometimes visiting these even when at some distance from the nearest forest—nasturtium, cannas, lilies, and even roses and peach-blossoms. Nevertheless at the present time, considering the whole range of the bird, its main supply of nectar is furnished by the Ohia, which is not only the most abundant of all forest trees but can also be found in flower either at high, low, or moderate elevation in the mountains at all seasons of the year. However as I have pointed out in the introductory remarks there is little doubt that, had the Ohia existed on the islands throughout the period of the evolution of the avifauna, or at least had it existed in its present abundance, as the chief constituent of the forest, the Iiwi in its present form would not have been developed. This development must have taken place when more or less deep tubular flowers, many of which are quite clearly very ancient components of the forest brush, yielded the main supply of nectar, for obtaining which the beak of the Iiwi is specially adapted, both in length and form. Besides the nectar of flowers, which on some occasions is the only food to be found in the stomach, this bird is especially fond of looper caterpillars, and so far as I have observed feeds its young entirely on these. It also feeds on those species of spiders

which are so commonly found on the limbs of forest trees, alive or dead. When hunting amongst the leaves of large Koa and other trees it has a quick, gliding movement, noticeable also in a few of those species most closely allied to it. Its conspicuous black and scarlet plumage is particularly pleasing when seen in the densest and gloomiest forests, so generally devoid of colour and where scarcely any sunlight can penetrate. Here it frequently visits the white campanulate flowers of the underbrush, and as in such situations it is very tame all its movements can be examined with ease at a distance of two or three paces.

The Iiwi when taking its long flights to or from a special feeding-ground mounts to an unusual height in the air, and in these flights several individuals often keep company. The beat of their wings is very audible even when they are high up and at a distance, and is perhaps produced in part by the more truncated apices of their primaries, since it is most noticeable in this and allied species which have the feathers so formed; in fact it is almost confined to these.

The song of the Iiwi is harsh, strained and discordant, the finer the condition of its plumage the more cracked as a rule does its voice become. When the birds are paired and the male is singing to his mate he can often be approached very closely, and no less from the appearance of the bird itself than from the notes does this song appear to be forced out with difficulty. When however large numbers of these birds are found in neighbouring trees mixed with other species, especially the Apapane (*Himatione*), and a regular concert is kept up, the combined effect is not unpleasant. As an alarm or call note the Iiwi gives utterance either to a rather loud unmusical squeak or a clear and distinct whistle. Both call notes and song appear to exhibit some variation in different localities. The yellow black-spotted young follow the parents sometimes till they are far advanced in their red plumage, but they very early learn to obtain nectar for themselves, even at a time when the parents are still feeding them on caterpillars. The changes that take place in the plumage from the young to the adult state are of much interest and are so great that the natives considered some of these stages to be distinct species. This is a curious error and detracts much from our opinion of their powers of observation, seeing that the birds in full plumage are constantly to be seen in company with and feeding their young. Such an error might easily be made by a museum student with insufficient material for study, but it is extraordinary how those who have seen the birds in life could be so deceived. The black markings of the plumage are sometimes very late in disappearing, and in one (the male) of two already paired, shot in the early spring months, black-tipped feathers so far remained as to form a black oblique streak for an inch or more from the shoulders on each side. Some of these black-tipped feathers were still yellow as in the young, others already scarlet, around the occiput yellow black-tipped feathers were still scattered among the red ones. Dissection of these two birds showed that they were already in condition to breed, even if they were not already nesting.

The nest of the Iiwi is larger than that of *Chlorodrepanis*, and not of a very compact or neat appearance. It is usually placed in tall Ohia trees, but occasionally in trees of lesser growth, such as the Mamane (*Sophora*). It is built of dry stems, leaves and rootlets, and the least inartistic specimens that I have seen are formed to a considerable extent of skeletonized capsules of the Poha.

1. *Vestiaria coccinea*, Forster.

HAB. Abundant in the forests of all the islands.

CIRIDOPS Wilson.

Native name *Ula-ai-hawane.*

Formerly widely distributed on the island of Hawaii, to which it was restricted, and known to have inhabited both the Kona and Hilo districts as well as the Kohala mountains, the Ula-ai-hawane is now one of the rarest of native birds and may perhaps be entirely extinct. Very little is known of its habits, but according to Emerson on native testimony, it was "wild and shy, a great fighter, a bird very rarely taken by the hunter." It seems to have been found only in the neighbourhood of the Loulu palms (*Pritchardia*), the blossoms of which as well as the unripe fruit supplied it with food. The palms themselves seem to have been always of sparse or local distribution, and still exist singly or in scattered clumps in the dense forests above Hilo, where I have often observed them, as well as in the Kohala mountains and the Kona district. The only specimen of the Ula-ai-hawane obtained in recent years was an immature bird shot by a native in the neighbourhood of these palms in the Kohala mountains about ten years ago, from whom it was purchased by the Hon. Walter Rothschild's collectors. The reputed pugnacity of this bird is quite in accord with what one might expect, and is characteristic of the section of the family to which it belongs, which seems generally to consist of stronger birds, well able to drive from their food those of similar habits in the other section. If, as we have reason to suppose, the Ula-ai-hawane obtained its chief food supply from these palms, which are themselves by no means abundant and are known to have been visited by other Drepanididae species, this pugnacity may well have been developed to an unusual degree.

(1) *Ciridops anna*, Dole.

HAB. Various districts of Hawaii formerly, now very rare.

PALMERIA Rothschild.

Native name *Akohekohe.*

The single species which constitutes this genus is confined to the neighbouring islands of Molokai and Maui, on each of which it is locally abundant. In its habits it

very closely resembles the Apapane, which is often to be found in company with it. Why the range of the larger bird should be now so restricted on the islands on which it is found, as compared with that of *Himatione*, is not manifest, but we know that on both the islands named it had formerly a far wider range than is now the case, and it is possibly more susceptible to those changes that have in recent years taken place in the forests than is the other. Woods opened by the invasion of cattle it sooner or later, as I have myself noticed, deserts, retiring to deep gulches where they cannot penetrate, and from these depths it can be called, while in the surrounding and more open forest not one can be seen or heard.

Its diet of nectar appears to be obtained almost entirely if not solely from the flowers of the Ohia, and the whitish frontal crest is sometimes filled with the entangled pollen grains from these blossoms. It is also partial to caterpillars, and not only obtains those which feed upon the foliage but also searches the dead branches of trees in dense wet woods for those which feed on this substance. When feeding on the Ohia blossoms it is aggressive to other birds, especially to the Apapane, which it drives off, but is itself similarly treated by the Oo (*Acrulocercus*).

Its call note is a simple clear whistle, very easily imitated, and by this means the bird can always be easily called in numbers in a good locality. It is uttered most often naturally on the approach of the mountain fogs, which are so frequent in the favourite localities of these birds, when they call freely to one another across the gulches. The adults, though easily called and curious, are less tame than the young, as is shown by their restless movements when they are attracted, but in dense, untrodden forests they will not infrequently approach the collector from mere curiosity, without any imitation of the call note being necessary. On one occasion I assembled no less than nine adult birds at the same time in one small Ohia tree not more than twenty feet high, and a pair of adults and several young were quite an ordinary gathering. Even when fired at and obviously touched by the shot I have been able to call this bird back into range and secure it at the second attempt.

The young follow the parents often until they have arrived at almost their full plumage, and after they have acquired their full song, but in the winter months these companies are mostly disbanded. In February and March they are generally paired and ready to nest, and are then clothed in their finest plumage. *Palmeria* has the characteristic odour of the family in a varying degree, it being as I have elsewhere noticed much more pronounced in some specimens than in others. Its song is quite distinct from that of any other bird, and when fully rendered consists of a most curious low vibrating sound, then ends with two or three sounds rapidly uttered, and sometimes omitted, which might be expressed as follows: hurr hurr—gluk gluk gluk. There is, however, no difficulty in tracing some resemblance between this song and some of the varying sounds produced by others of its allies, such as the Apapane and Iiwi. Though less lavish of its song than either of the last-named birds, yet it may often be heard, and

when about to sing it will often perch on the topmost branch of a dead tree or an isolated dead branch of a living one. Its song like that of the Iiwi appears to be forced out with difficulty and lacks all beauty. It has too other cries, especially a soft note not greatly differing from that of *Drepanis*.

(1) *Palmeria dolii*, Wilson.

HAB. Molokai and East Maui; local, but abundant where it occurs.

HIMATIONE Cabanis.

Native name *Apapane*.

The Apapane is extremely abundant throughout the mountains of all the islands, from the lower edge to the highest parts of continuous forest, but there is often much variation in the number of residents in a special locality according to the season. On Oahu when the Ohia trees of the lowest timbered regions are in flower I have observed this bird in numbers far below the region of continuous forest in scattered clumps of these trees. It is also quite common even now in the scanty forest immediately behind the city of Honolulu. In Cook's time it even visited the coast in so apparently inhospitable a locality as Kealakekua Bay, frequenting the flowers of the coco-nut palms with other forest birds. Changes wrought by the white man have been slow to reduce the numbers of this bird, and some others which like it are, as compared with the majority of the Drepanididae, little specialized in form or habits.

The Apapane is a great nectar eater, and this it procures mainly from the red flowers of the Ohia, while of animal food caterpillars, of which it is particularly fond, are obtained from many trees. It is often very numerous in the large Koas, because these trees are greatly affected by looper caterpillars, but it thrives equally well in forests where are no Koa trees, as throughout the islands of Lanai and Molokai and certain districts of other islands. Taking the same long and high flights as the Iiwi with similarly audible wing-beats, it can, and when necessary does, pass over a wide area in search of the Ohia blossoms, as well as making regular migrations when the flowering season demands. Thus when camped on some of the islands on the highest ridges, which divide the windward and leeward forests, I have often noticed the Apapane as well as one or two other species regularly passing high overhead day after day to that side where the Ohias were in full flower, returning towards evening to the side whence they came. In these cases small companies generally travel together, and vast numbers often collect in a favourite feeding ground, whether attracted by flowers or the abundance of caterpillars. When seeking the latter the Apapane passes quickly over the foliage with a gliding motion.

It is a most untiring songster and its song though short is pleasing, but from constant repetition becomes wearisome. Its call note is a plaintive whistle.

It nests chiefly from March to June but sometimes as early as January, and those

nests which I have seen the birds in the act of building (and they have been many) have always been placed in the thin topmost branches of tall Ohia trees and quite inaccessible without special climbing appliances.

As in the Iiwi, the various changes which the plumage undergoes, in passing from the young to the adult stage, are highly interesting.

It may be here mentioned that the outlying island of Laysan has at some time been colonized by the Apapane, which has there developed a distinct form, *Himatione freethi*, not included in this list. The habits of this species appear to be as similar to those of the Apapane as the very different conditions under which it lives will allow. It feeds on insects and the nectar of such flowering shrubs as are found on this low lying island.

(1) *Himatione sanguinea*, Gmel.

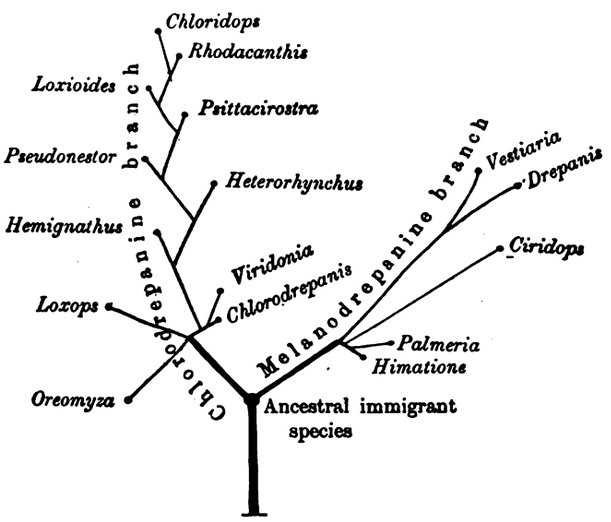
HAB. Abundant throughout the mountain forests of the whole group.

CHLORODREPANIS Perkins.

Native name Amakihi; *C. parva* Anianiau.

With *Chlorodrepanis* we pass to the second series of genera, which may be called the Chlorodrepanine as opposed to the Melanodrepanine section, the latter containing all those genera which have been previously dealt with. The characters of these two sections have already been stated in the introductory remarks on the family.

The appended genealogical tree represents the relationship of the various genera to one another in each of the two branches of the family, as they appear to me. The early division into two branches, if it took place within the islands, as I suppose, may really be due to some such simple cause as melanochroism, producing first a distinct species, which subsequently gave rise to a distinct line of its own. It would not be difficult to find arguments in support of this theory, whether we consider the birds alone or other divisions of the fauna. In each of the two groups the more primitive colour of the young often largely disappears in the adult, either of one or of both sexes, probably owing to the operation of sexual selection.



RELATIONSHIP OF GENERA OF DREPANIDIDAE.

There are three well-marked species of the genus *Chlorodrepanis*, two of which

inhabit Kauai only, and one intermediate between the two Kauai forms is found on all the other forest-clad islands. This latter has been described under four names, supposed to represent as many distinct species, one being peculiar to each of the four islands inhabited, but the distinctions between them are very insignificant, and the colour of the plumage of the adult males in some of these is known to me to exhibit considerable variation, when large numbers of individuals are examined, even in the same locality and at the same season. Consequently I have not thought it advisable to keep these forms apart in the list until I am assured that they can be invariably distinguished without the aid of a locality label.

With regard to the two extreme forms being found on the single island of Kauai, we may aptly compare this genus with the Turdine *Phaeornis*, which presents an exactly similar case.

All the species of *Chlorodrepanis* are among the most abundant of the existing Drepanididae, and even on Oahu, where so large a proportion of the species are entirely or practically extinct, the Amakihi is quite common, while on the other islands it is extremely numerous and generally distributed throughout the forest. Perhaps the larger of the two Kauai species (*C. stejnegeri*) is on the whole the least abundant, although a sufficiently common bird.

The wide diversity of food accessible to the Amakihi, and the ready manner in which it can adapt itself to conditions much changed by the importation of foreign plants and insects, gives it an enormous advantage over more highly specialized forms. All the species are partial to the nectar of flowers and at certain times this forms a very large part of their food, but their insect diet is also unusually varied. For the latter they seek in all sorts of situations, on the trunks and limbs of trees as well as amongst the foliage, and even ferns and low plants are often visited. The larger Kauai species (*C. stejnegeri*), which is a stronger bird and has a stouter beak than the others, is more constant than these in its attention to the trunks and limbs of large forest trees, and makes the nearest approach in its habits to *Heterorhynchus*, but more or less attention is paid to these by the Amakihi on all the other islands. The little Anianiau (*C. parva*) on the other hand attends more exclusively to the foliage and blossoms for its food. All alike obtain their nectar chiefly from the flowers of the Ohia, not however neglecting many other nectar-producing plants. From the lobeliaceous plants with shorter corollas they can obtain the nectar in the usual manner, while the longer ones they have learnt to pierce at the base, at least in certain localities. Many white campanulate flowers of the underbrush are eagerly visited, as also those of the banana, and in parts of Oahu they are very partial to the nectar of the introduced lantana. In the Iao valley on Maui great numbers were noticed at the flowers of the introduced cannas, which there form some extensive patches. On occasion they are even fruit-eaters, for at times *C. stejnegeri* may be seen day after day feeding on the red berries of the Akia (*Wikstroemia*), and in the higher forests of Hawaii *C. virens* comes even to the ground

for the berries of the Poha (*Physalis*). On Oahu the Amakihi took to feeding on a scale-insect (*Lecanium*), with which the leaves of the Kukui trees were some years ago very much infested, and specimens shot in these trees had their stomachs entirely filled with these insects. All the species of *Chlorodrepanis* are of a sociable disposition and often form little companies when feeding, or join those of other birds. Towards the nesting season however the pairs separate, and generally keep to themselves, the one sex following the other as they pass from tree to tree in their feeding grounds. As they get separated from time to time, they keep in touch by uttering their squeaking call note at intervals, and when the distance between them becomes considerable, the one rejoins the other. The song of the Amakihi is a short trill, and when at its fullest loud and penetrating, but not very musical. It may be represented by a 'chee' uttered a number of times in rapid succession. In the smaller Kauai species the song is a little different, the voice being less loud than that of its congeners.

In *Chlorodrepanis* the peculiar odour of the family is very strongly marked, so much so that sometimes even after a company of these birds have left a particular spot, the air remains tainted by the smell. I may here remark that this odour is not perceptible in all the species of the Drepanididae, nor necessarily in all the individuals of a species that possess it, unless perhaps at certain periods of its life, but it is more or less noticeable in the great majority of genera and in both branches of the family. Thus it is particularly powerful in *Drepanorhamphus*, and was strong in some individuals of *Palmeria* in the one section; in the other it is strong and probably always distinct in *Chlorodrepanis*, *Hemignathus*, *Heterorhynchus* and *Psittacirostra*, and I noted it (without special remark) in *Viridonia*, *Pseudonestor*, *Loxioides*, *Rhodacanthis*, *Chloridops* and certain specimens of *Loxops*. Birds of the other genera have it at most indefinitely, or not at all, but they are easily infected by lying in proximity to those in which it is strong.

On one occasion I shot an Amakihi which carried a parasitic[1] Hippoboscid fly, the latter being a very distinct species from either of those which were found infesting the short-eared owl and the Iiwi. Unfortunately the fly itself was struck and mutilated by a pellet of shot which partially imbedded it in the flesh of the bird.

The nest of the Amakihi is a simple structure, and I have noticed it on all the islands in many kinds of trees, sometimes at no great height from the ground, and poorly concealed. It is often built largely of dried roots, leaves, and twigs, and lined with finer rootlets. The least inartistic specimens are formed to a considerable extent of the skeletonized fruit capsules of the Poha, as is the case with those of *Vestiaria*. The newly-hatched young have a wide, short beak very different from that of the adult. It is not till some time after they have flown that this part reaches its full development in this and in many of the other genera of Drepanididae. The eggs of *Chlorodrepanis* are figured in the Proceedings of the Zoological Society for 1897 (Pl. 51 figs. 6, 7) and in the work of Wilson and Evans.

[1] *Ornithomyia varipes* Walk. Vol. III. pt. II. p. 89 of this work.

There are two points in connection with *C. parva* which may be noticed here. It will be observed that I have changed the native name as given by the various writers on Hawaiian birds, who have either copied from one another, or at least probably obtained the name from the same source. The name adopted by me was obtained from a different source and it has two points of superiority over the other, (1) it has an obvious and distinct meaning, (2) it is admirably adapted to the bird in question, A-nianiau meaning simply straight-beak, the most obvious point of distinction between itself and the Amakihi. It may be noticed that it is composed of exactly the same letters as the name given by other authors.

In their work on Hawaiian birds Wilson and Evans have mentioned the name *Rothschildia* for *C. parva*, but in saying that I intended to establish any such genus they are entirely in error. In the Ibis (January, 1895) I fully discussed the relationship of this bird, pointing out the differences between it and *Oreomyza* and describing the tongues of each, and expressed the opinion that it could not be separated from *Chlorodrepanis* (then included in *Himatione*). I have since repeated this statement, nor have I ever had reason to change my opinion. It would certainly be incorrect to suppose that *C. parva* is in any way a connecting link genealogically between *Oreomyza* and *Chlorodrepanis*, for even the form of its beak (wherein almost solely the resemblance lies) is obviously due simply to the diminution in size of this organ, in correlation with the small size of the bird itself. *Oreomyza* and *Chlorodrepanis* are, whether considered from the point of view of habits or structure, entirely distinct genera, and *C. parva* is in reality in no sense "intermediate" between them, as has been stated, because it superficially resembles the former in one or two trifling characters, while differing in those of a most important nature.

(1) *Cholorodrepanis virens*, Gmelin.
" " var. *chloris* Cab.
" " var. *chloridoides* Wils.
" " var. *kalaana* Wils.
" " var. *wilsoni* Rothsch.

HAB. Hawaii; the varieties on Oahu, Lanai, Molokai and Maui respectively. All the forms are common and generally distributed in the forest of the islands they severally inhabit.

(2) *Chlorodrepanis stejnegeri*, Wilson.

HAB. Kauai; common.

(3) *Chlorodrepanis parva*, Stejneger.

HAB. Kauai; very common.

VIRIDONIA Rothsch.

Native name unknown.

The single species of this genus is one of the most local of the Drepanididae, since it has so far only been found in the forests behind Hilo on Hawaii on either side of the Wailuku river, at an elevation of from 1200—3000 ft. above the sea. Were it not for its distinct song and call note, this bird might easily be passed unnoticed, unless one were specially searching for it, on account of its general similarity to the other very abundant species which it resembles. I find on reference to my notes that I paid three visits to the locality for *Viridonia*, each of them during the winter months, and on each about two weeks were spent in camp deep in the forest. During my first visit I saw but two specimens and obtained only one of these, but became acquainted both with the song and call note. For the whole two weeks it rained continuously throughout each day, which made collecting both disagreeable and difficult, and exactly similar weather was experienced during my second trip. On the latter however, in the course of a long march on one morning I saw as many as twelve of these birds, all single individuals or pairs, there being no young visible at this season. Six of these I shot at and killed and with no prospect of fairer weather I was content to return to Hilo. My third visit was entirely given up to entomological work, and the weather was as delightful as it had been abominable before, not a drop of rain falling during my fortnight's camping. On this occasion I noticed several individuals of *Viridonia* almost every day, most of them in pairs, and in certain spots the same birds, no doubt, were seen many times, but I collected none of these, since all were in fully adult plumage like those already procured.

Nearly all the *Viridonia* seen by me were in the Ohia trees or more often in the dense masses of Ieie clothing the trunks of these trees, whence they were obtaining their food. In the eight examples that I dissected I found the small forest crickets of the genus *Paratrigonidium* to form a large part of this food in each case. Some of these crickets are specially attached to the Ieie and some live beneath the loose bark of large Ohias, while others are only found on certain ferns, which on more than one occasion I noticed *Viridonia* visiting, no doubt in search of these insects. Caterpillars and spiders were also taken from the bird's stomach as well as a common carabid beetle, which lives at the base of the Ieie leaves, where these are closely attached to the stem. For obtaining the latter and the crickets which live in the same situation, the strong beak of *Viridonia* is well adapted. Once only I saw one feeding at the flower of the Ohia, and although I was unable to procure this for examination, I have little doubt that it was feeding on nectar, since its tongue is still unchanged from the form exhibited by that of the most persistent nectar-eaters. As in some species of *Oreomyza*, *Loxops* and *Heterorhynchus* the habit of feeding on nectar probably survives as a rare occurrence,

the typical form of the tongue being fully preserved, since it assists in obtaining some of these insects which form a large part of the bird's food, and not because nectar is of much importance as an article of diet.

The song of *Viridonia* is, as might have been expected, very similar to that of its near ally *Chlorodrepanis*; indeed it would be difficult to distinguish between them were it not that the former whistles two or three distinct additional notes after completing the Chlorodrepanid trill. Many times my attention was called to the presence of *Viridonia*, when I was engaged in insect-collecting, by its song, and but for this it would certainly have been passed unnoticed. It has also a soft cry as a call or alarm note, which somewhat resembles that of *Drepanis*, and by imitating this it can sometimes be called even within a few feet of the observer.

The natives of the present day have no name for *Viridonia*, although those to whom I have shown it, have always recognised it as distinct from any other bird. As far as I can judge, it is one which would have been unlikely to have been caught by the means adopted by the old bird-hunters, and even had it been caught its dull plumage would have been of little value, as the easily caught and extremely abundant Amakihi furnished feathers of a similar or superior quality.

(1) *Viridonia sagittirostris* Rothschild.

HAB. Hilo district of Hawaii; a very local species.

OREOMYZA Stejneger.

Native name varying with the species, *Alauwahio* (*Alauwi*, *Lauwi*), *Kakawahie*, *Akikeke*.

As the species of this genus exhibit great dissimilarity in the superficial appearance of the adult males, they were distinguished by several different native names. The three most nearly resembling each other, *O. maculata* of Oahu, *O. newtoni* of Maui, and *O. montana* of Lanai are called Alauwahio, or by the shorter name Alauwi or Lauwi, indiscriminately in each case. The Molokai bird, *O. flammea*, is the Kakawahie, *O. bairdi* of Kauai the Akikeke. *O. mana* of Hawaii is not distinguished by natives of the present day from the Amakihi (*Chlorodrepanis*), but it is unlikely that a bird so different in voice and habits had no special name in the days of the old professional bird-hunters. Both the Kauai and Molokai species no doubt received their names from the characteristic cry which distinguishes *Oreomyza* from all other native birds —the reiterated 'chip,' with which they resent the presence of an intruder.

I have found all the species of *Oreomyza* to be abundant in the islands that they severally inhabit, each forest-clad island possessing a species peculiar to itself.

O. mana of Hawaii is a very abundant bird and generally distributed over the large island. Nevertheless it is absent from some localities where it might naturally be expected to occur. Thus in the middle Kona district, though extremely common at an elevation of about 3500 ft. and upwards, it was altogether wanting in the lower forest, its range coinciding exactly with that of *Heterorhynchus* in the same locality. Seeing that the lower forest with its magnificent Koa trees seemed admirably adapted for both species, I at first supposed that the climatic conditions of this region, with its comparatively heavy rainfall, were unsuitable, but subsequently both were found in company in great abundance in the lower forests of the windward side of the island, where the rainfall far exceeds that of the wettest belt in the Kona district. In the dry upper woods of Kona and Kau, as well as the lower rain-soaked forest of Hilo district, *O. mana* is extremely common, yet the climatic conditions are as different as can well be imagined for so small an area of distribution. In a considerable extent of the Puna forest the bird is likewise absent, but here the Koa is also wanting, and for this tree it has a decided predilection in other localities. The two closely allied species *O. newtoni* and *O. montana* inhabiting Maui and Lanai respectively are each abundant on its own island. The former, extremely abundant as it is on Haleakala, is hardly less so in the widely separated mountains of west Maui, and it can be found from the lower to the extreme upper edge of continuous forest. *O. montana* is ubiquitous throughout the Lanai forest from 2000 ft. to the actual highest point of the island. The abnormally coloured Kakawahie with its fine red plumage is common both on leeward and windward Molokai. It is most partial to dense and wet forests, but not rarely small companies stray down the wooded gulches considerably below the line of continuous woodland. The Oahuan *O. maculata* is less numerous than any of these, though a common enough species, and is found on both mountain ranges, but it seems to have entirely disappeared from the mountains in the immediate neighbourhood of Honolulu, where it formerly occurred. *O. bairdi* abounds in Kauai both in the upper and lower forest region.

The call or alarm note of the species which frequent the intermediate islands of the group is actually or practically identical, that of *O. bairdi* and *mana* of Kauai and Hawaii more or less different, but the general resemblance is so great that no one who has once heard the voice of *Oreomyza* can mistake it for that of any other island bird. It is noteworthy that the two last-named species are subgenerically distinct from the others. Two members only of this genus have I ever heard sing, namely the closely allied species of Maui and Lanai, and the latter of these only on few occasions, and this in spite of the fact that I have seen hundreds of the Oahuan bird and thousands of all the others. Apparently they sing only under stress of intense excitement, as for instance when one male has been successful in driving off another from its domain. On such occasions I have seen the victor rise spirally upwards to a height of twenty or thirty feet pouring out its little song while on the wing and then suddenly darting

down again to cover in the underbrush. *O. newtoni* is less sparing of its song than is its ally, and in the spring months I heard it not very infrequently in the West Maui mountains, where in the Iao valley the bird came down even into the bushes of the introduced guava. This song is a short trill, distinctly more melodious than that of *Chlorodrepanis*, but in a general way resembling it. In both these species the 'chip chip' of call or alarm remains unchanged, and in all the others this, or a slight modification of it, is the only sound uttered.

In the brush of unfrequented forests the *Oreomyzae* are very tame and readily approach the collector, often several together, and even as many as a dozen, those in the surrounding country being attracted by the cries of the first arrivals. At all seasons of the year it is noticeable that these groups, in the case of such species as show striking sexual dimorphism, rarely contain more than one male in fully adult plumage, the proportion of such males appearing to vary between one to four in other plumage at or near the breeding season, and one to a dozen or even considerably more after this time. I believe that this disparity is caused by a large mortality amongst the younger birds and not to the fact that a lengthy period is necessary for the assumption of the finest plumage. Observations made on certain species would tend to show that this is fully acquired within a period of twelve months and that many of the young perish before acquiring it. However the fact that the birds breed at irregular seasons, so that young just from the nest may be found at almost any time, makes it very difficult to ascertain the true state of affairs in the field. It is quite certain that in some localities two, if not more, broods are produced in the course of the year. No doubt a much larger proportion of fully adult males would often appear in collections, because of a natural tendency on the part of the collector to pick out an undue number of specimens in their brightest plumage, although these adults are generally less tame than the immature individuals. My observations on the numbers of adult males are taken from field notes made in localities where I have been able to examine not usually less than one hundred individuals in the course of a day's collecting. On one occasion of 127 *O. flammea* examined 18 were adult males, or 1 in 7, and I believe this would be a fair average proportion for this and other species, as estimated for all seasons of the year.

In habits all the species of *Oreomyza* are very much alike, a large part, and in some species nearly the whole, of their food being obtained from the trunks and limbs of the forest trees and bushes. All are expert at climbing upon these, working either upwards or downwards, and along the upper or under side of the horizontal branches. *O. mana* is extremely partial to the large Koa trees and the undergrowth of bastard sandal, mamani, etc. of the lesser trees. In the former *O. bairdi*, *O. maculata* and *O. newtoni* also abound in some localities, but they thrive in forests absolutely destitute of Koa. Thus over extensive areas on Kauai the Ohia is to *O. bairdi* what the Koa is to *O. mana*, and of the lesser trees the underbrush of Kalia (*Elaeocarpus*) is as favourite

a resort of the former, as the bastard sandal is of the latter. I have noticed that all the species come down to the base of the trunks and sometimes even on to the ground itself, and some habitually hunt in the masses of creeping ferns, as well as on the fronds and stems of those which form large trunks. The closely allied *O. newtoni* and *montana* alone appear to feed on nectar, visiting as a rare occasion the red flowers of the Ohia, the nectar of which is easily attainable by their short, and for honey-sucking purposes degraded tongues. Excepting these two species the *Oreomyzae* feed entirely on animal food, of which caterpillars and spiders form a large part. Myriapods, slugs, beetles and moths are also eaten; the latter if of large size they hold down with their claws, and tear off the wings before devouring them. Dead wood they search for the many species of caterpillars, which live in this substance, and those species of loopers or span-worms, which habitually hide beneath the bark of trees and in crevices during the daytime, are often found in the stomach, as well as those which feed exposed on the foliage. The Oahuan species has the knack of obtaining one of the most remarkable of the Hawaiian Carabid beetles in quantities, to judge from the remains found in the bird's stomach, yet for the entomologist it is difficult to obtain even a single specimen. I have little doubt that it obtains these from the interior of dead branches of lofty Koa trees, practically inaccessible to the insect collector, since they are generally found in those shot when feeding in this situation.

The beautiful Kakawahie of Molokai appears at first sight to be the most aberrant species of the genus, but is in reality closely allied to the Lanai and Maui species. It may be supposed that the change from yellow to red plumage is a simple matter in the Drepanididae, since in the adult male of *Loxops ochracea* in full nuptial and breeding plumage, the feathers are either red or yellow in different individuals or sometimes intermediate in colour. Even in the present species when in full nuptial plumage the colour is of a distinctly yellower red in some than in others. The young of *O. flammea* is extremely like some of the other species at certain stages, at one period having white super-orbital lines meeting on the forehead in front—markings so strongly developed in the young of *O. bairdi*, and manifest in others of the genus.

I have several times found the nest of *Oreomyza*, never with eggs, but once with a single young one hardly able to fly and still retaining a little of the down. It was placed in an Ohia tree at a height of about 20 ft. and resembled the nest of *Chlorodrepanis*, for which, but for the presence of the young, it might have been mistaken.

(1) *Oreomyza bairdi*, Stejneger.

HAB. Kauai. Common and widely distributed.

(2) *Oreomyza mana*, Wilson.

HAB. Hawaii. Widely distributed and very abundant in many localities.

(3) *Oreomyza* (subg. *Paroreomyza*) *flammea*, Wilson.

HAB. Molokai. Widely distributed and common.

(4) *Oreomyza* (subg. *Paroreomyza*) *montana*, Wilson.

HAB. Lanai; common and generally distributed.

(5) *Oreomyza* (subg. *Paroreomyza*) *newtoni*, Rothschild.

HAB. Maui, both in the East and West divisions of the island; abundant.

(6) *Oreomyza* (subg. *Paroreomyza*) *maculata*, Cabanis.

HAB. Oahu in both the Waianae and Koolau mountain ranges; common.

(7) *Oreomyza perkinsi* Rothschild.

HAB. Kona. Hawaii.

NOTE. I have not seen this species, and before deciding on its validity it is essential that the generic characters should be critically examined. It seems to me extremely improbable that *Oreomyza mana* and *Chlorodrepanis virens* would ever interbreed, as is suggested. From the description it would appear much more probable that the unique specimen is a 'sport' of the last-named species.

LOXOPS Cabanis.

Native name of all the species (excepting *L. caeruleirostris*) "Akepa."

The four species of this genus have a very distinctive appearance, owing to their small size and comparatively long tail, which when they are seen alive appears quite conspicuously forked at the tip. This character readily serves to distinguish the green-plumaged young and adult females from other species superficially resembling them, when, as often, they are feeding in the same trees in a mixed assemblage.

All the species excepting the Oahuan *L. rufa* are common locally on the islands that they inhabit, Molokai and Lanai alone being without a species.

L. coccinea of Hawaii is very widely distributed on that island, and in parts of the Kona district, in Kau, Hilo and the Kohala mountains is abundant. It is extremely partial to the Koa forests, but is found in localities where are none of these trees, as in the forest between Kilauea and Keauhou (in Puna) and elsewhere. *L. ochracea* on Maui is also often seen in the Koa trees but more often in the Ohia, which latter are the favourite feeding ground of *L. caeruleirostris* on Kauai.

The various species of *Loxops* are amongst the most active of native birds and their name Akepa, signifying 'sprightly,' 'turning this way and that,' is singularly appropriate. This name is applied by well-informed natives of the present day to both the species inhabiting Maui and Hawaii, and Bloxam gave the same name for the Oahuan form three-quarters of a century ago. For the Kauai species Scott Wilson gives the name Ou holowai, but in various parts of that island I have been assured by natives that the true name is Akekee. If the latter, as I suspect, be correct, it is very appropriately applied, and would indicate that the natives had observed a noticeable generic character of *Loxops*, namely the abnormally bent mandible. It is true that Andrews says the Akekee is 'a small brown bird resembling the wren, found on Waialeale Kauai,' which could only refer to the fly-catcher (and of which Wilson's Apekepeke might perhaps be a corruption); but as he is sometimes clearly in error in the remarks on birds made in his dictionary, and some extremely well-known species are altogether omitted, I am disposed to accept this name as correctly applied to the *Loxops* by living natives, who showed themselves well acquainted with other birds of the same island. It is certainly strange if the 'Elepaio' (*Chasiempis*), a bird so famous in song and legend, was given a distinct name on Kauai alone, for though the Kauai form is specifically quite distinct, in its voice, habits and superficial appearance it agrees with those on the other islands. On the other hand the *Loxops* of Kauai is a bird which, when adult, is of very distinctive appearance and highly characteristic of the avi-fauna of Waialeale.

In their general habits the species of *Loxops* approach most nearly to *Chlorodrepanis*, since they obtain their food chiefly from the foliage of the trees, and not like *Oreomyza* from the stems, branches and trunks. They are largely eaters of caterpillars, feeding not only on the common exposed span-worms or loopers, but seeking also the more hidden smaller kinds, which feed in the leaf-buds, or are otherwise concealed. The abnormal structure of the mandible is clearly connected with the habit of seeking food in the closely imbricated buds of some of the forest trees. *L. coccinea* seeks its food largely amongst the phyllodes of *Acacia koa*, the favourite food plant of many caterpillars, but, when it frequents woods composed almost entirely of the Ohia, it, like its allies, pays most attention to the ends of the branches and the terminal buds. Even in the dry upland forests it by no means confines its attention to the Koa, but often comes low down into the bastard sandals, alii (*Dodonaea*) and other of the lesser trees, not only for feeding purposes, but often during the mid-day heat to enjoy a siesta in the superior shade afforded by these trees. In the forests a few miles from the crater of Kilauea on the Kau side, where the bird is abundant and as many as a dozen, young and old together, may be seen in a single Koa tree, it is pleasant to watch these little birds, still hardly for a moment, as they flit from twig to twig in search of food; and in the heart of the forest on Mauna Kea in Hilo district with its entirely different climate they are perhaps even more numerous. On Kauai *L. caeruleirostris* keeps chiefly to the high

plateau where it is both numerous and widely distributed, but in the winter months it may be occasionally seen in the lower forests, no doubt being driven down to these by stormy weather. It is often seen in small companies of six to a dozen individuals, and often accompanied by other birds, especially the species of *Chlorodrepanis* and *Oreomyza*.

The food of all the species of *Loxops* consists very largely of caterpillars and spiders, but as was the case in *Oreomyza*, two of the species of this genus also—*L. caeruleirostris* and *ochracea*—feed more or less rarely on the nectar of the Ohia blossoms. The thin, long, honey-sucking form of tongue is fully preserved in all, in spite of the small attention paid to such food, but with the distorted mandible it is obviously a very efficient help in procuring the larvae which feed in the terminal buds of trees as well as those which live between leaves fastened together, which I have seen them extracting. Some of the species obtain wood-feeding larvae to some extent, but they seek for these less than does *Chlorodrepanis*, and far less than *Oreomyza* or *Hemignathus*. When exploring the bark of the branches of trees, it is generally for those spiders, which live on the surface, that search is made, as I have satisfied myself by dissection of birds obtained whilst feeding in this situation. There is no doubt that *Loxops* is of high value in the forests and destroys quantities of insects, which are well concealed and obtained only to a comparatively small extent, or not at all, by the other native birds. For many of these hidden larvae they compete rather with the native wasps than with other birds.

I have in an early paper on Hawaiian birds noticed the fact that one of the most characteristic peculiarities of structure of the species of *Loxops* is the more or less asymmetrical mandible, which tends more or less to cross the maxilla. This twisting of the lower jaw is either to the right or left according to the individual, and varies also in amount. This peculiarity naturally calls to mind the much greater asymmetry shown by the beak in the crossbills, as it of course did to Cabanis, when he applied the name *Loxops* to the Hawaiian bird. Dr Gadow, in his second paper contributed to Wilson and Evans's work, says that this twisting of the mandible is acquired individually, and is due to the fact that the birds twist open seeds and cracks of bark in search of food and that it is smallest in young birds. The latter statement is no doubt sometimes true, but that it is so is due to the fact that in very young birds the beak is altogether less developed, and the asymmetry, which is never great, is consequently less apparent. Thus too in the long-billed Akialoa (*Hemignathus*) the difference between the length of upper and lower jaw is often much less striking in the young than in the old bird, because in the former the whole beak is less developed. Again, in the amount of this difference in length there is individual variation both in young and old of the Akialoa, and the case may well be compared with that of *Loxops*.

The essential use of the distorted mandible of *Loxops* is without the least doubt for the extraction of insects living hidden in the leaf-buds of certain forest trees. These

buds may not inaptly be compared to the pine cones from which *Loxias* procures its food, although their much softer substance by no means requires the more powerful implements of the crossbill. As has been already mentioned the bill of *Loxops* is also useful in opening out the Koa phyllodes, when fastened together by certain caterpillars, or by some spiders (of which it is extremely fond) which thus conceal their nests.

The full song of each of the four species of *Loxops* is a short trill, nearly or quite identical in all. The adult female of *L. coccinea* sings more musically, but still more softly, than the male. Her song is generally uttered from the dense cover of some tree of the underbrush, the notes sometimes being repeated at such short intervals as to form a practically continuous song lasting for some minutes. The call note is a simple 'keewit,' much less loud than the otherwise similar call of some other species, such as *Heterorhynchus*.

Sexual dimorphism is extremely marked in the adults of all the species, excepting *L. caeruleirostris*, the ♂ of which to a large extent preserves the green plumage exhibited only by the female and young of the other species. *L. ochracea* is unique in the two distinct forms of its fully adult males, these being distinctly red or yellow during and previous to the nesting season, when their plumage is finest. There are however individuals more or less intermediate between these two forms. The most deeply coloured examples approach very closely to *L. rufa* of Oahu. The red males of *L. coccinea* and probably of other species pass through a stage (non-breeding) when the plumage is largely of a greyish colour, a similar phase being shown by *Oreomyza flammea*. This phase is also more or less noticeable in many of the green-plumaged birds of other genera, though less striking than in the red species above-mentioned, and is probably pretty general in this section of the family, but I think not exhibited by the other section (*Himatione*, etc.). The fully adult females of *L. coccinea* show very considerable variation in the colour of their plumage even at the same season, that is when nesting or about to nest. In all the species of the genus, excepting *L. coccinea*, the beak is largely of a bluish colour in the adult, but in that species when alive or freshly killed, it is extremely different, being largely of a pale yellowish colour.

On one occasion I saw a pair of the Maui species building their nest high up in a tall Ohia, near the extremity of a horizontal branch. Both sexes kept coming to the ground for material and were carrying off the woolly down or 'pulu' of some stunted tree-ferns, probably as a lining for the nest. This was so well concealed that even with glasses I was unable to make out the details of structure with any certainty, and the eggs and unfledged young I have not seen.

(1) [1]*Loxops coccinea* Gmel.

HAB. Very generally distributed on Hawaii, and in many places abundant.

[1] If I remember rightly there is a Hemipterous genus *Loxops* (Fieb. 1858) also, curiously enough, with a species *coccineus*.

(2) *Loxops ochracea* Rothsch.

HAB. Haleakala Maui; abundant in some localities. Not noticed in the mountains of West Maui.

(3) *Loxops rufa*, Bloxam.

HAB. Oahu; now very rare, but no doubt attainable, since I recently heard a pair calling to each other far back in the forest, when I was engaged in entomological work. The call note is identical with that of *L. aurea*.

(4) *Loxops caeruleirostris* Wilson.

HAB. Kauai; common over a large part of the high plateau.

HEMIGNATHUS Lichtenstein.

Native name *Akialoa* or *Akihialoa*; but formerly on Oahu and Kauai *Iiwi*.

In their habits the species of this genus are quite intermediate between *Chlorodrepanis* and *Heterorhynchus*, since they are greater nectar-eaters than the members of the latter genus and hunt more persistently, creeper-like, on the limbs of forest trees for wood- and bark-eating insects than does the Amakihi (*Chlorodrepanis*). In general structure they much resemble the latter, differing chiefly in their stronger build, the excessive elongation of the beak, the entire absence of setae at the base of the nasal openings and the relatively extremely short tail. In the latter respect they closely resemble *Heterorhynchus*, but apart from the very different form of beak, they are at once distinguished from that genus, since it has the nasal openings well protected by setae.

Two of the four known species are now excessively rare, namely the *H. lichtensteini* of Oahu and *H. lanaiensis* of Lanai, in fact it is possible that either or both of these may be now extinct. Of the former the only specimen known to exist is that which, collected over half a century ago, is now in the museum at Berlin, and we have no reason to suppose that the bird within historical times was other than a great rarity, or that a second example was ever obtained. However, on one occasion, I saw a pair of this species, the one chasing the other over a narrow ridge high up in the mountains. The leading bird passed over this ridge and down into the deep gulch on the other side, squeaking as it flew, the other alighted in an Ohia tree on the top of the ridge about 10 yards in front of me. The latter when I shot dropped over the steep edge and after much searching I was unable to find it. I distinctly noticed the sombre plumage of the upper parts, which in no way approached the yellower colour of the other species with which I was then familiar.

Almost equally unfortunate was my experience of *H. lanaiensis*, of which I saw but a single example. This was evidently an adult male, its plumage appearing quite

brightly yellow, and unlike any of the figures in Mr Rothschild's work. There is no doubt that his figure of the adult bird, if really taken from an adult, represents the bird in its non-breeding stage, for in January, when I saw the one above mentioned, all the adult birds on Lanai were in the fullest and most perfect plumage. It was extremely tame, at times not five yards distant, hunting for insects along the trunk and large limbs of a partly fallen Ohia, which overhung the edge of a precipitous cliff. As, if killed, it would necessarily have fallen in the brush far below, or have lodged in the shrubbery on the side of the cliff, being without a dog I forbore to shoot, and when after some minutes it flew off, it was seen no more. It is probable that this was really a survivor of the brood obtained by Mr Rothschild's collectors, since Wolstenholme, who discovered the bird, informed me that all of their specimens were obtained in the same spot and practically at the same time. Certainly the bird seen by me was quite alone, and this at a time when mature birds were all paired, and it may even be feared that it was the sole living representative of its species. If, however, a few pairs remained it is possible that the Lanai Akialoa may even have increased in numbers, as I am told that the forest of that island has improved rather than deteriorated since I made my last visit.

The other two species of the genus, the one peculiar to Kauai the other to Hawaii, are common enough, though less numerous in individuals than the species of *Chlorodrepanis*, *Oreomyza* and *Loxops*. The Akialoa of Hawaii I found to be more widely distributed, but less numerous than its *Heterorhynchus*; the Kauai species much more widely spread and at the same time much more numerous than its Nukupuu (*Heterorhynchus*). *Hemignathus obscurus* has been found in each district of the large island and frequents both the lower and upper parts of the continuous forest. It was common in Kona in 1892 and 1894, not only in the denser forest but also in the open parts at all elevations, abundant in Kau district in the Koa woods three or four miles from Kilauea, numerous in the heart of the virgin forest of Mauna Kea, north of the Wailuku river, as also in the Kohala mountains. In Olaa it was less common, at least at 1500 to 2000 ft., where I chiefly observed it; and here the magnificent virgin forest has now been cut down for the purpose of planting coffee and sugar-cane. The still finer species, *H. procerus* of Kauai, I noticed generally throughout the forests of that island, wherever I collected birds, from nearly the highest point of the mountains to 1500 ft. and even at lower elevations.

The species of *Hemignathus* differ but little in their habits from one another, certainly not more so than do the individuals of a single species, when they occupy localities where the climate and general conditions are extremely different. The two common species are both partial to the nectar of some kinds of arborescent Lobeliaceae (called Haha and Oha-wai by the natives), especially to those with large corollas, while to certain kinds they pay no attention at all, however profusely they may be in flower. In the heart of the forest on Mauna Kea, during three weeks of continuous rain in the winter months I daily observed the Akialoa visiting these flowers; as also on the

rough lava-flows in the Kona district on the other side of the island. When visiting the Haha, the bird is often exceptionally tame, and with a little care all its movements can be watched from a distance of only a few paces, and when it is only a few feet from the ground. *H. procerus* on Kauai likewise obtains nectar from the same remarkable flowers, and is likewise fastidious in the choice of species that it frequents, some of the most abundant Lobeliaceae (even when well-liked by other honey-suckers) being rarely, if ever, visited. At times, even when the Akialoa was feeding on insects, and in places where I noticed no flowering lobelias, I found the forehead to bear more or less evident traces of the pollen of these flowers, showing that they must have lately visited these. Wolstenholme himself informed me that he shot the Lanai Akialoa, while they were seeking the deep-seated nectar of the Haha.

At other times both the common species resort to the flowers of the Ohia with their exposed nectaries. In Kona *H. obscurus* was common in the very tallest flowering trees, frequently two to eight in a single tree, but requiring to be looked for amongst the extraordinary numbers of commoner Drepanids. In some localities and at certain seasons the Kauai bird is an eager visitant to the Ohia flowers. One of the best localities known to me for entomological work was an open dry slope of an acre or two, which lay in the midst of a forest consisting largely of Koa trees, and in and about this spot I spent many successive days in the spring months. In the middle of the open space grew several low and bushy Ohia trees, at that season covered with flowers, although those in the surrounding forest bore few or none. To these isolated trees the Akialoa would come at intervals throughout the day, sometimes a number of individuals being present at one and the same time. Yet in the surrounding forest the birds appeared to be always hunting for insects on the branches of the trees, and were not seen to pay any attention to such flowers as were to be found. In other localities and on other occasions I have made similar observations, and I am quite satisfied that the different kinds of Akialoa are all still largely nectar-eaters, although possibly on the way to become entirely insectivorous. In the following genus, *Heterorhynchus*, we see a still further advance in the latter direction, indeed one of the species (*H. wilsoni*) already feeds on insects and spiders alone.

The insects on which *Hemignathus* feeds are sought for mainly in similar situations to those affected by *Heterorhynchus*, namely in or beneath the bark of trees and in decaying wood; and in fact the very same species are frequently found in the stomach of each of these birds, but those of the first named genus have a more varied diet. In the large Koa trees of open woods in Kona from 2000—3000 ft. above the sea the Akialoa could be traced by its audible tapping on the bark, the sound resembling that produced by the strokes of the beak of the Nukupuu, except that it was less loud. In the excessively wet forests of windward Hawaii it was sometimes seen on the stems of the tree-ferns, or amongst the masses of climbing Ieie (*Freycinetia arborea*), exploring with its long beak in the first case the cavities of the stems of old fronds, broken off close

to the caudex, and in the second the bases of the stiff clasping leaves and the débris found there, in both of which situations insects habitually harbour. In most of the higher forests, where the rainfall is less, the Akialoa is mostly attached to the Koa, though it visits the lesser trees, Mamani, Naeo and stunted Olapa, and on Kauai comes even to the ground in the Ohia forests, when, no doubt, it is in search of fragments of lava, such as are sometimes found in its stomach.

The species of *Hemignathus* are fond of spiders, which they chiefly obtain on or beneath lichen-covered bark, and of many insects, which hide beneath the bark of trees, or actually live on this or the wood beneath. Amongst these are Geometrid caterpillars which secrete themselves by day; wood- and bark-eating Gelechiid larvae or such as feed in the rubbish which collects in the forks of trees or at the bases of the leaves of certain plants; beetles in the mature state, such as arboreal species of Carabidae rarely, the small metallic weevils of the genus *Oodemas* (favourite food also of the Nukupuu) very freely in many localities, Anobiidae in some districts; larvae of the latter and of Cossonidae, and others. In addition to these in the Kauai bird were found specimens of the small native cockroach and of certain remarkable crickets (Prognathogryllides), quite peculiar to the islands. For obtaining such insect food the long, slender, curved beak and brush-tongue is as admirably adapted as it is for extracting the hidden nectar in the long curved tubular corolla of the Lobeliaceae. To a small extent the Akialoa feeds on leaf-frequenting insects, occasionally picking off caterpillars, or even making a dart at some more active form.

Several times, both on Kauai and Hawaii, I have killed a specimen when feeding woodpecker- or creeper-like on the surface of a tree-trunk, and it has remained suspended from the tree by its beak alone, this organ at the moment of death having been thrust into some crevice or insect burrow, which it was probing for food. I have seen *Heterorhynchus wilsoni* suspended by the curved maxilla alone in similar fashion.

The song of *Hemignathus* is a short, vigorous trill, recalling that of both *Heterorhynchus* and *Chlorodrepanis*, but distinct from either. It has a louder and deeper call or alarm note than the latter, and this too is easily recognizable. Both the Kauai and Hawaii bird sing quite freely at certain times and places, and it is remarkable that when feeding on the nectar of flowers they are more lavish of this song than at other times. In this connection it may be noticed that of the *Oreomyzae* the two nectar-eating species alone have been heard to sing, the song being as rare as the nectar-eating habit, and it would appear possible that in these genera such a diet is a stimulus to song.

I once saw the nest of *Hemignathus obscurus*. It was built towards the extremity of one of the largest spreading branches of a Koa, placed above a fork and well concealed. It contained only one young one, and that already able to fly, while a second one was seen sitting on the branch outside the nest, with the old birds. The nest itself so far as I could get sight of it appeared to be quite similar in form to that of *Chlorodrepanis*, but was better concealed amongst the lichens covering the branch, and these

appeared to have been partly used in its construction. This nest was found at the end of June, and in the same district (Kona) many young birds were noticed at the time being fed by the parents.

Like many other Drepanididae[1] the species of *Hemignathus* are grievously affected by a disease, which is probably contagious, and causes swellings on the legs and feet, as well as on the head at the base of the bill, and on the skin around the eyes. One individual of *H. procerus* affected in all parts I picked up on the ground, it being quite unable to fly. Quite recently (Feb. 1902) two individuals of *Oreomyza flammea* were examined, one of which was crouched on the ground at the foot of a bush, the other in the middle of a dense shrub. Both of these birds were affected on the head, and neither would move until they were actually poked up. In other cases birds, on which these growths are largely developed, appear not to suffer very serious inconvenience. Sickly birds generally retire to dense cover to die, so that it is difficult to estimate whether the disease causes much mortality. I have no doubt it is sometimes fatal. It not only affects the smaller birds but the crow, the buzzard, the introduced pheasant and even the Californian quail are sometimes attacked, and a similar disease is very disastrous to tame poultry. It is quite probable that the disease was introduced with the latter.

The Kauai *Hemignathus* is also subject to the attack of internal parasites of two kinds, the remarkable *Apororhynchus hemignathi* of the Acanthocephala, and the tapeworm *Drepanidotaenia hemignathi*. The former is the sole representative of a (so far) peculiarly Hawaiian family (Apororhynchidae), the latter is congeneric with the tapeworms of other birds. A second species of tapeworm attacks the *Loxops* of Kauai, and I think the *Hemignathus* as well.

Although *Hemignathus* is now widely known under the name Akialoa on the various islands, it formerly, both on Kauai and Oahu, was called Iiwi or Iwi, the red *Vestiaria* being distinguished as Iiwi-polena, Iiwi-popolo, &c., according to the colour of its plumage. Though the Oahuan bird was said by its discoverers to be called 'Jibi' by the natives, this is clearly an error for Iiwi, the *I* being changed into *J*, just as the Iao valley is not infrequently misprinted 'Jao,' while the difference between *w* (sounded as *v*) and *b* is not great.

(1) *Hemignathus obscurus*, Gmelin.

HAB. Hawaii; in all the districts, and not rare in many localities.

(2) *Hemignathus lanaiensis* Rothschild.

HAB. Lanai; but very rare.

(3) *Hemignathus lichtensteini* Wilson.

HAB. Oahu; now very rare, perhaps extinct.

[1] "Ibis," Jan. 1893, p. 112.

(4) *Hemignathus procerus*, Cabanis.

HAB. Kauai; at various elevations and in many localities, not at all rare.

HETERORHYNCHUS Lafresnaye.

Native name *Akialoa*, *Akialoa nukupuu* or *Nukupuu*.

Four well-marked species are included in this remarkable genus, one member of which is peculiar to each of the four larger islands, while on Lanai and Molokai it is unrepresented. Of the four known species the Oahuan *H. lucidus* is almost certainly extinct, no individual having been obtained for many years. From such information as I have been able to gather from native or other sources it occurred in some numbers at least until about 1860, and frequented what must now be considered as the lower belt of continuous forest, its range in fact being apparently that of the Koa tree. Over the greater part of Oahu the Koa fails long before the main ridge of the mountains is reached, and an examination of the lower edge of the existing forest shows that a large, and probably much the larger part of the Koa belt has now been destroyed. If the bird was really restricted to this lower forest I should consider its total extinction as almost certain. The specimens obtained by Deppe and Townsend in 1837 were from Nuuanu valley, at no great elevation above the sea and were said to frequent the flowers of the banana. No doubt at that time the valley was densely forested for the greater part of its length, since Bloxam records that in 1825 he visited its head by a narrow path through a dense and shady forest. Lying as it does immediately behind the city of Honolulu this fine valley is now practically denuded of its forest and largely filled with unsightly guava scrub; and the cliffs on either side, which to Bloxam appeared bare in comparison with the valley itself, now alone retain their native vegetation. Of late years some attempt has been made to reforest the head of the valley, but the exotic trees now planted are a poor substitute for the many rare and beautiful native species, which once flourished there; nor is it likely that any reforesting will bring back the birds which the American and Prussian naturalists found so plentifully some sixty-five years ago.

The Kauai species (*H. hanapepe*) is by no means a common bird, and its range is rather restricted. It is found on the high plateau of that island, but only over a limited portion, whence came the original specimens obtained by Wilson. At lower elevations (from 2000—3000 ft.) it can be obtained in the forests forming part of the Hanapepe water-shed, on the west side of the main river. Here it can always be met with in certain favoured spots frequenting the Koa trees.

Even more restricted is the range of *H. affinis*, as at present known to me, on the

north-west slope of Haleakala, where it is chiefly found about a mile below the upper edge of the forest at an elevation of 4000—4500 ft. above the sea. Here it is often found in company with *Pseudonestor*, which would, however, appear to stray both above and below the range of *Heterorhynchus*. It is rather more numerous in individuals than the Kauai species, since on some occasions a dozen or more adults have been observed on a single day, while rarely have we seen half that number of *H. hanapepe*, even when well accustomed to their habits and favourite haunts. Of course of either species a greater number may perhaps be noticed in a day's hunting at a time when the young are still following the parents, but on the other hand it is quite possible to search very diligently for a whole day on either island and not get a glimpse of either species.

Far otherwise is it with *H. wilsoni* of Hawaii, which is not only widely distributed over that island, but is abundant in localities differing greatly in their climates. In the middle Kona district this *Heterorhynchus* was numerous in the forests of mixed Koa Mamani and Naeo from 3500 ft. upwards. Below this elevation it was not seen, its range being almost exactly identical with that of the underbrush of the bastard sandal (Naeo), the fine Koa trees below this elevation, and situated well within the wet-belt, having no attraction for the bird. This is the more curious when one considers that it is very much at home in the Koa trees of the Hilo forest with its excessive rain-fall, where I found it commonly from 1500 ft. upwards. A few miles from the volcano in Kau it can be observed to great advantage at close range, as it is particularly fond of the stunted bushy Koa trees, that are occasionally met with in those woods. These it habitually frequents in company with the Akialoa (*Hemignathus*) and several other birds, and numbers can be seen on any favourable day. It is also found in the Mamani woods of the Waimea district.

Of all the native Drepanid birds none are more interesting in their habits than the species of *Heterorhynchus*. The three existing species of the genus very greatly resemble each other in this respect, seeking their food in the same manner and feeding on similar forms of insect life. Their climbing movements are more perfect than those of other birds, and they creep over the tree-trunks either upwards or downwards with equal ease, and hunt both along the upper and under surface of the branches. On the 11th of July, 1892, in the high forest of Kona I first had the opportunity of watching one of these birds in pursuit of food, and as I was able to examine all its actions for a long time and at a very short distance, both with the naked eye and with field-glasses, I have little to add to the account then written, after similar observations on many other individuals. The bird in question was an adult male in fine plumage, and when first seen was about 10 yards off, but showed no fear when I approached it much more closely. It was visiting one after another a number of fallen tree-trunks, large but smooth-barked examples of *Acacia koa*. Along each of these it proceeded from one end to the other, peering now over the right side of the trunk and now over the left, so that in a single journey it searched both sides of the tree without retracing its steps. The upper

mandible is thrust into small holes or cracks in the wood, while the point of the lower presses on the surface of the bark, and in this manner the burrows of wood-boring insects are opened out. So too it thrusts its upper beak under loose pieces of bark, resting the lower one on the surface, and breaks off fragments of the bark, under which its food is concealed. The upper mandible, though so slender as to be slightly flexible, is very strong, and this flexibility of the beak aided by the extreme flexibility and strength of the neck no doubt greatly assists the bird in exploring and opening out the burrows. In extracting and capturing its prey it also employs the thin brush-tongue, which can be extended to the length of the upper mandible. At frequent intervals it gives several blows to the trunk, the sound of which can be heard at a considerable distance. These blows are dealt with great vigour and with the beak wide agape, so that the point of both mandibles comes in contact with the surface at the same time. On one occasion I watched one lying on a branch of the mamani and basking for a time in the hot sun. Now and then it would lazily turn its head and peck at the bark without otherwise changing its position. Suddenly it started up and began to feed in earnest, dealing blows on the bark with savage energy. Into these blows it throws its whole weight, swinging backwards from the thighs to renew its stroke. In some cases these blows, if not for the purpose of driving out hidden insects, at least have that result, for several times I saw the bird after a stroke make a sudden dart, sometimes even taking an insect on the wing. Though less powerful than those of some other allied birds, the muscles of the head are unusually developed, as indeed are those of the legs, neck and other parts of the body, and the whole bird is of remarkably compact and sturdy build. Not infrequently it lays hold of a projecting piece of bark or the stump of some small broken branch, and shaking its head from side to side and pulling in all directions, endeavours to tear it out. If unsuccessful in the attempt, it will alternate this treatment with a shower of blows from the points of its gaping bill, till either the stump gives way or the labourer is convinced of the futility of further efforts.

Though greatly attached to the Koa the Nukupuu of Hawaii does not disdain some of the lesser trees, especially the Mamani (*Sophora*) and the Naeo (*Myoporum*). In none of the various localities where it abounds, does the nectar of flowers form any part of its diet. For the Ohia, even where it is the predominant forest tree and attains a great size, it has little or no liking, although in restricted localities it visits the climbing Ieie (*Freycinetia*) with which these are clothed. In this respect it differs from its relatives on Maui and Kauai, which may frequently be seen hunting along the larger limbs of a big Ohia.

In their manner of feeding both the Maui and Kauai species greatly resemble *H. wilsoni*, but they are, though very active, less vigorous in their movements, when hunting their prey. Both hammer on the surface of trunk or branch and produce a tapping sound, audible at a distance, but it is generally much less loud than that of the Hawaii bird. They moreover entirely agree with one another in all their habits. *H. affinis* on

rare occasions sucks the nectar of the flowers of the Ohia, and *H. hanapepe* is said, on native authority, by Wilson to eat bananas and oranges, which no doubt means visits the flowers for nectar. So the natives say of many birds that they "eat lehua" i.e. obtain nectar from these flowers. As already mentioned, the Oahu species had a similar partiality for the banana flowers. Of all the species of *Heterorhynchus* the insect and other animal food consists to a large extent of spiders, which live exposed on the surface of branches or amongst the lichens which cover these; of caterpillars of Tineidae which live in dead wood, such as *Thyrcopa*, those that live within cases being swallowed case and all, and of larvae of some wood-boring beetles. Looper caterpillars, of such species as hide by day beneath the bark, are frequently eaten, and even those which live exposed upon the foliage, during their periodical swarming. But considering the various species of *Heterorhynchus*, as examined in all localities and at all seasons, their favourite food would appear to be the small brassy weevils of the genus *Oodemas*, a form not less peculiar than the birds themselves. In many localities these beetles invariably form a considerable portion of the contents of the stomach. As these beetles as well as a large proportion of the larvae eaten by *Heterorhynchus* feed solely on wood absolutely dead, these birds have not by any means so great an economic value in the forest as might be supposed, in fact the large number of spiders that they kill largely discounts their services as eaters of looper caterpillars. Though they habitually frequent trees infested with the native Cerambycid beetles they appear to trouble these rarely or not at all, either as larvae or as adult beetles. For this reason *H. affinis*, feeding side by side, as it sometimes does, with *Pseudonestor*, and constantly frequenting the same trees, enters but little into competition with this species, which is constantly on the hunt for these larvae. Strongly built as is *Heterorhynchus* it probably requires the much stouter beak and huge muscles of the allied genus, to open the burrows and extract the grubs of these beetles with sufficient expedition to make them a profitable food. All the species of *Heterorhynchus* are of a sociable disposition, so that when feeding they often join or are joined by several other kinds of birds. This fact makes it far easier to obtain the rarer species, especially *H. hanapepe*, than would otherwise be the case. It is only necessary to listen for the 'chip' of *Oreomyza*, which is constantly iterated when one passes near a company of this bird, and proceed to carefully examine the mixed assemblage of species. Frequently in these gatherings, it may be in some lesser tree of the underbrush, such as the Kalia (*Elaeocarpus*) or a partially decayed Olapa (*Cheirodendron*), quite as often as in some larger forest tree, it happens that amongst half-a-dozen or more *Oreomyza*, a pair or two of Elepaio and Akialoa, several *Chlorodrepanis*, and possibly several Oo overhead, a pair or even several individuals of the Nukupuu will be quietly feeding. Sometimes nearly all the known forest birds of Kauai may be found in a single assemblage of this kind, the perfect climbing movements and extremely short tail at once betraying the Nukupuu, when its beak is not visible to the collector, and its voice

is not heard. As it is scarcely possible to pass within hearing of such a gathering without its presence being revealed by the clamour of *Oreomyza*, augmented by that of the Elepaio and other species, many companies can be daily examined and the Nukupuu secured, if not on the first day, at least with comparative ease and certainty.

All the species of *Heterorhynchus* occasionally come down to the ground in quest of fragments of lava, which are no doubt swallowed for the purpose of grinding up the extremely hard brassy weevils, already mentioned as being a favourite food. Although I have frequently observed this habit in all the *Heterorhynchi* from dissections of the body, yet only twice, once on Hawaii and once on Kauai, have I seen the bird on the ground in the act of swallowing these pieces of lava. In each case the bird was standing on one of the narrow paths made by the cattle through the underbrush and trodden bare by these.

The song of the three species is very similar and is a short, loud trill. It is loudest in the Hawaii bird, but otherwise like that of the others. That of the Maui species varies somewhat, and it would appear to make some attempt to imitate the introduced *Carpodacus*, which abounds in the same forest. All are, at most seasons of the year, fairly lavish of this song, and frequently interrupt their search for food to give it utterance. The call note is a loud "kee-wit," very clear and distinct, when the birds are in solitary pairs, and by it the sexes keep in touch when feeding in different trees. This call note degenerates at times into a loud monosyllabic squeak, especially when the bird is alarmed.

Neither the nest nor egg of any species has been observed, unless an example of the former, mentioned under the following species, really belonged to *H. affinis*.

It should be noted that *Heterorhynchus wilsoni* of Hawaii is structurally distinct from the other three species generically, if all the many other proposed genera of Drepanididae be retained. Thus the differences between such genera as *Vestiaria*, *Drepanis*, and *Drepanorhamphus* are very small, as also are those between *Loxioides*, *Telespiza*, and *Rhodacanthis*; and all these might well be included in two genera.

(1) *Heterorhynchus hanapepe*, Wilson.

HAB. Kauai; local and not common on the high plateau, and about some of the side gulches of the Hanapepe watershed (2000—3000 ft.).

(2) *Heterorhynchus lucidus*, Licht.

HAB. Oahu; formerly, now probably extinct.

(3) *Heterorhynchus affinis* Rothsch.

HAB. Maui; on the north-west slopes of Haleakala at 4000—4500 ft. Not rare.

(4) *Heterorhynchus wilsoni* Rothsch.

HAB. Hawaii; widely distributed and common in many localities.

PSEUDONESTOR Rothschild.

The single species of this genus is another most extraordinary development of the Drepanid type. It is more closely allied to *Heterorhynchus* than to any other existing genus of the family, its short tail and robust form, as well as its general habits and its song, all reminding one of the Nukupuu. It differs from that genus chiefly in the enormous development of the beak, which is of great size and compressed form, affording a large surface for the attachment of the great muscles of the jaw, which are necessary for performing its work; and further, in the loss of the typical tubular character of the tongue.

It also calls to mind the Ou (*Psittacirostra*) and is without doubt intermediate in some respects between the two genera. It must not however be supposed that the passage from the thin-billed Drepanididae to the thick-billed, as exemplified by *Psittacirostra*, actually took place through *Pseudonestor* as now constituted, but rather through some lost form, in which the characters of the existing *Pseudonestor* were less extremely developed.

But for the small size of the female the sexes of *Pseudonestor* differ very little, and what must be considered a [1]primitive style of coloration is retained through life. This similarity between the sexes is of very rare occurrence in the green section of the Drepanididae, but is again conspicuous in *Chloridops*, a bird likewise of sluggish habits, and most of whose time is likewise occupied in obtaining food.

So far as is known *Pseudonestor* is restricted to a small portion of the forest on the north-west slope of Haleakala, at an elevation of 4000—5000 ft. It is frequently seen in company with *Heterorhynchus affinis*, and I have killed both birds at a single shot. It is extremely partial to the Koa tree, and at most seasons obtains its food almost entirely from these. This food consists for a great part of the larvae, pupae and immature beetles of the native Cerambycidae, but more especially of *Clytarlus pennatus* and *modestus*, enormous quantities of which it destroys. It also visits other trees occasionally, especially some kinds of *Pelea*, whence it obtains the larvae of *Plagithmysus*, leaving remarkable scars on the tree as a token of its visit. It feeds its young partly on these and partly on looper caterpillars, but they very soon learn to extract the beetle larvae for themselves.

Pseudonestor is generally a sluggish bird, with little of the activity of the Nukupuu (*Heterorhynchus*), although in its movements it in many respects closely resembles the latter. Thus in hunting along a fallen tree-trunk it examines both sides in a single journey from end to end; in opening out the burrows of the *Clytarli* it often wrenches

[1] Many other Drepanididae in acquiring the adult plumage pass through a stage in which the markings are similar to those of the adult *Pseudonestor*.

and pulls in a very similar manner; it frequently clings to the under-side of a branch and by stretching its neck raises its head above it, before laying hold of the upper surface with its beak. It is in this position that it bears most resemblance to a diminutive parrot, but the size and shape of the beak greatly increase the resemblance. The twigs and smaller branches of the Koa, in which the *Clytarli* are found, are never rotten, but generally even drier and harder than the healthy, growing wood, and require enormous strength to open them. To perform this, the branch is gripped by the curved upper mandible and the lower one opposed to it, and the burrow of the larva is exposed, either by the act of closing the beak or by wrenching with it, the somewhat slender tongue assisting in extracting the prey.

Pseudonestor in its native haunts and away from houses is a very tame bird, so that it can readily be watched, exhibiting little or no fear of the observer. On one occasion, when camped beneath some tall Koa trees at about 4000 ft. above the sea, I constantly observed these birds in the tree to which my tent was attached. They are unwearying in supplying their full-fledged young with food, and when the latter are soliciting this from their parents they form a most comical group.

The call note of the adult bird is a loud 'kee-wit,' which cannot always be distinguished from that of *Heterorhynchus*. The song is quite similar to that of the latter, a short, vigorous trill, at its best fully as loud as that of the Nukupuu of Hawaii. It also has a squeaking cry as an alarm note. Occasionally it sings on the wing as it passes from one tree to another, but more often the song is heard from some Koa tree, for the bird, like the Nukupuu, interrupts its labours at intervals to give it utterance. In my original notes on the species I compared the song to that of the green *Himatione* (i.e. *Chlorodrepanis*). At that time I had seen and heard but few of these birds and these were out of condition. Since 1894 I have seen and heard them scores of times, and the similarity of the song to that of *Heterorhynchus* is certain.

On one occasion I found a nest in a Koa tree which could only have belonged to this species or to *Heterorhynchus affinis*. It was built in the fork formed by a branch and the main trunk about 25 ft. from the ground. The tree was covered with grey lichens and the nest was well concealed, being itself covered with the same. It was of simple cup-like form, resembling in this respect the usual Drepanid nest. For several days two old and two young birds, just able to fly, were constantly seen in this tree, and I feel sure that they must have been the former occupants of the evidently newly deserted nest.

(1) *Pseudonestor xanthophrys* Rothsch.

Hab. Maui, Haleakala, 4000 to 5000 ft. in company with *Heterorhynchus affinis*.

PSITTACIROSTRA Temminck.

Native name *Ou*.

Alone of the thick-billed, finch-like Drepanids, the Ou is of general distribution over the islands, and excepting on Oahu, where it is nearly or quite extinct, is in many localities a most abundant bird. In March, 1893, I saw a pair of these birds on this island far back in the mountains at an elevation of about 3000 ft. They were probably nesting and were exceptionally tame, the male bird in full song and plumage; and at one time, sitting side by side as they were, I could, had I been willing, have brought down the pair with a single shot. Since that year, although I have spent much time in the forests of Oahu, I have never seen or even heard another individual, though the song of the Ou and its call note are audible at a considerable distance, and cannot be mistaken for those of any other bird. Why the Ou should have become extinct on Oahu and remain abundant in far more restricted forests on Molokai and Lanai is by no means clear, but with regard to the former island it may be noted that now over extensive areas it is often difficult to find a single red Ieie fruit, which the foreign rats have not more or less eaten and befouled, and they may thus have indirectly brought about the extinction of the Ou, even if in times of scarcity of the fruit they do not actually prey on the bird itself. That the Ou is easily caught is proved by the number of times that, when on Lanai, I found the remains of those that had been killed by cats, and twice I shot these vermin while in the act of devouring this very bird.

As the essential food of the Ou is the inflorescence of the Ieie (*Freycinetia*) and its bill, as I have remarked in my earlier publications, is entirely formed and adapted for the purpose of picking out the component parts of this, when fruiting, so its chief home on all the islands lies in the belt which produces this plant. Not that it is absolutely confined to this belt for it is found both above and below it, but in some cases certainly, and perhaps in all, these wanderers return at times to feed on their favourite food. That the latter is the case is the more probable, from the fact that, as I have pointed out in the introductory remarks on the family, the Ou is with the Iiwi and Apapane remarkable for the power and extent of its flights, when seeking food. At all seasons I have found the Ou in the forests of East Maui above the range of the Ieie, as also on parts of the high plateau of Kauai, and elsewhere, but in all these cases no very extended flight was necessary to take it within the range.

In middle Kona, in 1892, where the bird was in countless numbers throughout the wet-belt, many of these strayed up into the dry and higher forest at the end of the fruiting season of the Ieie, and occupied the haunts of their ally the Palila (*Loxioides*), and fed almost entirely on caterpillars. So too, large numbers habitually strayed downwards below the range of *Freycinetia*, especially frequenting the clumps of Kukui trees, but many of these returned in the evening from these isolated clumps to the shelter of the continuous forest at a higher elevation. In Cook's time we are told that

they even frequented the inhospitable coast in this vicinity. On another occasion large numbers of Ou wandered upwards above the wet-belt to feed on the swarms of looper caterpillars that were defoliating the Koa, frequenting these trees in company with *Rhodacanthis*. A similar incursion for the same purpose was noticed in the Koa forests above Kilauea in Kau both in 1895 and 1896 in the summer months; and I have no doubt the true home of these wanderers was in the woods of Olaa. These were accompanied by large numbers of the Amaui (*Phaeornis*), and on the latter occasion the period of their stay was brief, lasting only for a space of about two weeks, when both species disappeared together.

Although the large female inflorescence of the *Freycinetia* is the chief food of the Ou, yet it also sometimes feeds on the male flowers, as well as on parts of the pretty red leaf-bracts which surround these. It also in a lesser degree eats the fruits of several other trees, and in forests above the range of the Ieie is very partial to the berries of some of the arborescent Lobeliaceae, and more especially to the large yellow ones of some species of *Clermontia*. In scattering the seeds of these, which like those of some other trees pass undigested through the alimentary canal, the Ou like the thrush is of great benefit to the forest, the more so on account of its wide-ranging habits. The fruit of the introduced guava, which has run wild and spread so widely over the lower parts of the mountains, is greatly appreciated by this bird, nor does it disdain other foreign fruits, which the white man has brought with him. Sometimes the stomach is entirely filled with green vegetable matter, apparently young leaves in a finely divided state. In some localities the bird pays great attention to the red flowers of the Ohia, and I have repeatedly noticed, both on Lanai and Kauai, that it visits these one after another on the tops of the tallest trees, thrusting its head amongst the numerous stamens. Specimens shot while so engaged contained only much finely-divided green vegetable matter, so far as could be distinguished, but I suspect that the exposed nectar of the flowers was really the attraction, although it could not be detected amongst the green stuff with which the stomach was quite filled. Like several other birds of the family, the Ou may not yet have entirely lost the nectar-eating habit, the structure of its tongue being such that it might easily obtain nectar from the Ohia flowers, as *Oreomyza* does on rare occasions. Certainly the birds that were shot while visiting the flowers contained no insect food whatever. The Ou feeds its young very largely with caterpillars, especially those of Geometridae, and at times, when frequenting the forests of lofty Koa trees, itself partakes of hardly any other food. It generally seeks these in the bushy tops of the very tallest trees and is not always by any means easy to get sight of, even when it is in reality quite numerous. When crammed with this food decomposition sets in very soon after death, more quickly in fact than when it is on vegetarian diet, and the skin over the posterior ventral half of the body should be opened and pushed back soon after death, or most of the feathers of the belly will slough off.

In many parts of the islands the Ou is a very tame bird, so that most of its actions

can readily be observed at very close quarters. In some woods however which have been much opened and traversed by cattle it has become both scarce and decidedly wary.

It has a rather sweet song, which at times reminds one somewhat of a canary, but is much inferior to a first-class songster of that species. Three or four very distinct and penetrating whistled notes form the beginning of its full song, and are highly characteristic. It sings very freely in the early morning hours, especially just before the nesting season, and when singing delights to perch on the loftiest dead branch that it can find. Sometimes it sings as it flies, and when a small company are on the wing together they not infrequently sing in concert, as they sometimes do at other times, and in a very pleasing manner. The call of the Ou is a rather long note, so whistled as generally to appear of an enquiring nature. To this it will readily respond again and again, and may by this means be brought close to the observer. In foggy weather especially, the birds are continually uttering this call, and often from this single note they break into their full song.

In the middle forest of Kona in June, I observed great numbers of the young, some scarcely able to fly, but neither eggs nor nest. These young were frequenting the dense masses of Ieie, with which the great Ohia trees growing on the roughest lava-flows were covered, and no doubt the nests are built either in the tangled climbers or the trees themselves. In some parts of the islands no doubt the nests might be found without much trouble by anyone who devoted special attention to the matter, but certainly not in localities like the one above mentioned.

Mr Rothschild has separated some old Oahuan specimens as a distinct species under the name of *P. olivacea*, but the characters given for its separation are very slight, and without the examination of many individuals their specific value is very doubtful.

(1) *Psittacirostra psittacea*, Gmel.

HAB. All the forest-clad islands. Extinct or nearly so on Oahu, but common on the rest of the group.

LOXIOIDES Oustalet.

Native name *Palila*.

The Palila is entirely restricted to the upper parts of the forest on the island of Hawaii, where it was found abundantly in the Kona and Hamakua districts, but I have some reason to believe that it has become less common of late years. In 1892 it was extremely numerous in the Mamani belt of the middle and North Kona district, from rather below 4000 ft. to at least 6000 ft. above the sea. In this region it nested in the Mamani trees, and here I saw many young in all stages from those scarcely able to fly to nearly mature examples, but was not able to find any nest containing eggs. Some years later I revisited this spot in the winter and early spring months, when I found the

adult bird in splendid plumage, but no immature examples. A few miles from the volcano of Kilauea the Mamani grows quite freely, and I was surprised to find none of the bird in that locality, since it much resembles its haunts in the Kona district.

The food of the Palila is to a very large extent derived from the Mamani trees, on the seeds of which it chiefly feeds. I have frequently seen it cut off a pod and hold it down on a branch with its claws in order to extract the seeds, as Wilson has already described. It feeds its young on caterpillars, and is itself at some seasons most partial to such food, a considerable variety of these being found in its stomach. Amongst these caterpillars is that of a conspicuous yellow, green, and black species of Pyralid, which it finds on the Mamani, and which is sometimes eaten so freely as to exclude all other food. It may be noted that this caterpillar possesses the so-called 'warning colours' in the highest degree, and theoretically should be inedible, yet it is actually chosen in a locality which abounds in the protectively coloured Geometrid caterpillars.

The Palila has a distinctly whistled call note which is easily imitated, and to an imitation of which it will readily respond. When answering, the call note often sounds of an enquiring or inquisitive nature, just as is the case with that of the Ou. It has too a distinct song, which is pleasing, but less so than that of the latter. Like the Ou it is of a sociable disposition, and frequently four or five or more adults in the perfection of plumage were seen in company during the winter months, while birds in immature plumage are nearly always accompanied by their parents long after leaving the nest.

Numerous in its special haunts, tame, and in foggy weather constantly uttering its call note, the Palila of the more local birds is one of the easiest to observe or collect.

(1) *Loxioides bailleui* Oust.

HAB. Hawaii, in Kona and Hamakua; locally abundant.

RHODACANTHIS Rothschild.

There are two described species of this genus, both of which are retained as distinct in the present work, although I am still somewhat doubtful as to the validity of the smaller. Mr Rothschild has no doubt whatever as to their distinctness, and Mr A. H. Evans, who examined the smaller, is I believe of the same opinion. On the other hand Mr G. C. Munro, who either shot the few specimens in question, or was present when they were shot, informed me that neither he himself nor Palmer had any suspicion that there was a second species, though he specially noted the difference in size and colour at the time. Certainly these smaller specimens were obtained at the same time and in exactly the same spot as the larger. Mr Munro further suggested to me that, as he had shot an occasional specimen of *Rhodacanthis* in the Aalii trees, possibly these yellow-headed birds might have been obtained in this way.

On a subsequent visit to the locality I paid special attention to this point, but the occasional examples of *Rhodacanthis* which strayed down to the Aalii, as likewise those in

other of the lesser trees, such as the Mamani or Naeo, were all of the typical and larger form. The occurrence of two species so closely allied, if they be distinct, and with presumably similar habits, inhabiting the same restricted area, is highly remarkable. It should not be forgotten in this connection that the fully adult males of the Maui *Loxops* are dimorphic, being either yellow or red, with rarer intermediates. There is no reason to suppose that these yellow birds ever become red with age but rather otherwise, when one examines the colour changes in the plumage of the closely allied *Loxops* of Hawaii, and those of the red Molokai species of the allied genus *Oreomyza* (*O. flammea*). It is therefore not impossible that the case of the two *Rhodacanthis* is in some respects analogous to that of the Maui *Loxops*. I have myself observed distinct variation in the tint of the green plumage of the adult ♂ of the larger species, and some in the depth of the feathers of the head, which are distinctly yellower in some; but even putting aside the question of measurements, I should not consider any of these as true intermediates between the smaller and the larger. Unfortunately it will be very difficult to gain much information as to the smaller species, unless some new locality be discovered. Munro informed me that he and Palmer saw in all a score or two of *Rhodacanthis*, amongst which were two or three of the yellow-headed species. In 1892 in a longer stay in exactly the same locality, I saw several score of the larger bird, and in two subsequent visits, the latter of which was made for the special purpose of investigating this matter, certainly some hundreds were examined with the naked eye or glasses, as the case required. On none of these occasions did I see a single one of the yellow-headed bird, nor did I hear any song or call note that could be referred to a species unknown to me. It is possible, and in my opinion even probable, that the yellow-headed specimens secured by Mr Rothschild's collectors were strays from some unknown locality, and only by chance occupied the range of the red-headed bird. The latter is the largest and most beautiful of the heavy-billed Drepanids. Unfortunately the golden sheen of the orange-reddish crown partially loses its lustre after skinning, and never again does the brightness of the freshly-killed bird return. In the winter months this plumage is at its best, and at this season the bird in life must be counted one of the most beautiful of Hawaiian species. Although spending most of its time in the tops of the loftiest Koa trees, *Rhodacanthis* occasionally visits the lesser trees, especially those already mentioned, chiefly for the sake of the caterpillars that feed upon them. Like the Palila, it sometimes devours large quantities of gaudily coloured species, as well as the more sombre brown or green looper caterpillars. Its chief food is however the green pod of the Koa tree, which it swallows in large-sized pieces, and its blue beak is often stained with the green juice and fragments of the pods. The development of the abdominal part of the body is large, possibly in accordance with the coarse fragments that it swallows, and in this it differs markedly from *Chloridops*, which feeds on the delicate embryos of the bastard sandal, and has the abdominal parts much less developed.

The song, if such it can be called, for apparently it serves also as a mere call, is entirely different from that of any other native bird. It consists of four, five, or even six whistled notes, of which the latter ones are much prolonged. It frequently differs somewhat as whistled by different individuals, and also is sometimes distinctly varied, when repeated by the same bird. Although the notes are not loud, they are very clear, and are very easily imitated, and the bird responds most freely to an imitation. Were it not for this fact *Rhodacanthis*, when keeping to the leafy crowns of tall Koa trees, as it often does, would be most difficult to get sight of. Not only is the male attracted by this means, but the female likewise comes, perhaps not less often than the male, but even when called into the tree, beneath which the observer stands, it is often difficult to locate her. In misty weather they are particularly ready to answer, and I have called as many as seven adult males and two females into one large tree at the same time.

The green-plumaged young, which greatly resemble the female, are fed partly on large fragments of Koa pods, such as their parents eat, both sexes being assiduous in feeding them. At this time the adult female can easily be obtained, but the plumage of neither adult bird is now comparable with its condition in the winter months.

When thoroughly scared the female sometimes gives utterance to a deep single note, which is repeated at frequent intervals with varying intensity, so as to have a ventriloquial effect, and make it extremely difficult to locate the bird. The young male soon acquires the full song of the adult, sometimes even before the crown of the head begins to assume the plumage of maturity and while the skull is still of soft consistency.

I have seen the male bird come down to the ground for building material and carry this to the top of one of the tallest Koa trees, and in this situation, in the locality frequented by the bird, certain largish nests which became visible later, when the trees were stripped by caterpillars, I have no doubt were built by *Rhodacanthis*.

(1) *Rhodacanthis palmeri* Rothsch.

HAB. Hawaii, in Kona district (4000—5000 ft.), and in Kau in the Koa woods some miles above Kilauea.

(2) *Rhodacanthis flaviceps* Rothsch.

HAB. Hawaii, Kona, mixed with the preceding species but much rarer and only obtained by Mr Rothschild's collectors.

Chloridops Wilson.

In this monotypic genus the gross development of the skull and beak surpasses that of any other Drepanid, and is carried to such an extent that in skinning the bird it is impossible to withdraw the skull through the skin of the neck.

Chloridops is found in the same localities in the Kona district as *Rhodacanthis*, but so far as known to me its range is more restricted, all the specimens seen being noted within an area of about four square miles, and even within this area the bird appeared local. There is no apparent reason why new localities should not be found for it, but it certainly is absent from extensive areas which appear to be admirably adapted to it. Within the area that it inhabits it cannot be considered other than a rare bird, and on the most favourable and exceptional days I have never seen more than 6 or 8 specimens, as paired or solitary individuals. It may be exclusively and diligently sought for a whole day, or for several successive days, without a single example being seen or heard, even when one is acquainted with its favourite haunts and habits. No doubt, when leading about its young, and when, as with so many Drepanids, apparently several broods unite together, a greater number might be met with, and in fact Munro on one occasion, as he informed me, met with such a group, containing not less than 8 or 9 individuals. However such assemblages must be rare, as I never was fortunate enough to meet with one, although I have seen the bird at various times during eight months of the year, and both in the hot and cold seasons. Several times I met with two and even three pairs in close proximity, but these appeared to be really quite independent of one another and merely to have gathered in some particularly favoured spot for feeding purposes.

Usually it is a dull, sluggish and solitary bird and spends nearly its whole time in feeding, mostly in silence,—unlike others of its allies, which at intervals interrupt their search for food to utter cheery song or call note. For the greater part of the year its food consists almost entirely of the embryos of the Naeo or bastard sandal (*Myoporum*), although I have known it to occasionally take a caterpillar. As the dried fruit of the Naeo is excessively hard, it is probable that nothing short of the extremely powerful jaws of *Chloridops* and their great muscles would be able to crack these. In cracking them a sound is produced, which is audible at some distance, and as it is incessant when the bird is feeding, by far the most easy way to get sight of this, is to listen attentively for the sound. The flycatcher when taking an insect on the wing frequently produces a somewhat similar snap with its beak, but the two sounds can always be distinguished. The somewhat sombre green plumage of *Chloridops* conceals it well amongst the foliage, so that, but for the snapping sound that it produces, it would probably be the most difficult to collect of all the forest birds, that are not on the very verge of extinction. It very rarely visits any other tree than the Naeo, but I have once seen it in the true sandal, the fruit of which it also possibly eats.

Only when the sexes are in pursuit of one another have I seen it exhibit any considerable activity, and on one such occasion I heard it utter a squeaking cry. A native whom I took to Kona with me on my first visit, however, told me that he once heard its true song, which was unlike that of *Rhodacanthis*.

Chloridops has a predilection for such Naeo trees as grow on the roughest lava-flows, but it also visits those which grow in and about the more open spaces in the forest. It is a tame bird, and of all that I saw, I doubt whether there was one which I could not have killed, had I wished to do so.

Neither *Chloridops* nor *Rhodacanthis* appears to have any native name. Various names have at times been given me for both of these birds, but of the accuracy of any of these there is the greatest doubt. Natives with a really extensive knowledge of the avifauna, to whom the skins were shown, declined to give them a name, and even suggested that they were 'malahini' (foreign). As a matter of fact *Chloridops* would have been likely to attract the attention of the birdcatcher in a very small degree, and *Rhodacanthis* from the very nature of its habits still less. It is doubtful whether the latter could have been obtained by any means employed by the native hunter, and certainly without the aid of field-glasses he would rarely have had a chance to study its appearance.

The birds of both these genera have the rank Drepanid odour in a marked degree, as indeed have the other heavy-billed forms.

(1) *Chloridops kona* Wilson.

HAB. Hawaii, Kona district, about 4000 ft. Very local, not having been noticed at a short distance to the north or south of its known habitat, in similar forest.

Fam. MELIPHAGIDAE.

ACRULOCERCUS Cabanis.

I have reverted in this work to the already well-known generic name *Acrulocercus* for the birds so extremely well known by the Hawaiian name of 'Oo,' dropping the utterly inappropriate name *Moho* given by Lesson. *Moho* is, as is well-known to inhabitants of the islands, who have even a slight knowledge of the avifauna, the native name of the small flightless rail (*Pennula*), and I have already found that its adoption as a generic term for the Meliphagine genus leads to misunderstandings and confusion.

There are four known species of *Acrulocercus*, one of which, *A. apicalis* of Oahu, is almost certainly extinct; and two of the others (*A. nobilis* and *bishopi*), though far from sharing its unhappy fate, have yet decreased very much in numbers within comparatively

recent times, and no longer occupy extensive tracts of country, where once they were very plentiful. Neither of these species thrives in forests opened by cattle, and as a rule they sooner or later entirely desert these, so that the area of forest land suitable for them has for years been diminishing.

The smaller bird of Kauai (*A. braccatus*), although it does not assemble in great numbers in a limited area as the Hawaii bird sometimes does, is both numerous in many places and widely distributed over that island. In its habits it differs very considerably from its allies, and a consideration of these habits may conveniently be postponed until the latter have been dealt with.

The Oo of Hawaii is the most timid and wary of all the forest birds, nor is this to be wondered at, when we consider that it has been persistently hunted for its few yellow feathers by many generations of men. On this account it is now, at most times and places, only to be seen in the tops of the largest and most lofty trees, but that originally this was by no means its invariable, if indeed its usual habit, is certain from observations made on the bird in places where it has probably been rarely or never persecuted. In such places the bird will come freely down into the low brush, where it may be seen visiting the flowers of arborescent Lobeliaceae for the sake of their nectar or those of some of the lesser forest trees, such as the yellow flowers of the Mamani. Nectar is unquestionably the chief food of this Oo, as also of its relative on Molokai, although each of them is to some extent insectivorous and in a small degree frugivorous. In Hawaii at the present time the blossoms of the largest Ohia trees furnish by far the most abundant supply of nectar, and it is while rifling these of their sweets that the Oo is usually seen. In the winter months the birds are often in scattered pairs throughout the forest in a favourable locality, but after the breeding season and while the young are still following their parents, many congregate in a small area, and at such times we have seen as many as a dozen in a single tree. The Oo is very agile in its movements when feeding amongst the Ohia flowers, gliding and darting from bloom to bloom and from limb to limb with great rapidity, at one moment one side, and the next far away on the other side, of some giant tree. It is very intolerant of the scarlet Iiwi (*Vestiaria*), and will at intervals suspend its feeding to chase away any of these that have ventured into its own tree, or it will even leave this, however profuse be the blossoms, to drive from some distant tree one that it has chanced to spy there. This aggressiveness appears so wanton and unnecessary, and so frequently interrupts its own feeding, that one suspects it must be an ancient habit, which has survived from a time when either nectar-producing flowers were scarcer, or the birds which fed upon them were much more numerous. In attacking the other nectar-eating birds it makes a savage rush on the one that excites its animosity, and as in making this attack it frequently erects its tail with the long twisted feathers, and also raises its wings, so that the yellow axillary feathers and under-tail-coverts of the same colour can be distinctly seen, it presents a very fine appearance. When in company

with its mate at or before the nesting season it likewise frequently assumes this position, and indeed various other postures and antics. After the nesting season the old and young together may be seen at only a moderate height in the Ohia trees, often amongst the masses of climbing Ieie, with which the trunks are clothed. On the red fruit of the Ieie the old birds sometimes feed, and at some seasons they are rather partial to caterpillars and some other insects. Their economic value in the forests is, however, not to be compared with that of many of the Drepanididae, both because the number of insects destroyed by them is much less, and because many of the insects killed are by no means injurious, and some are even probably beneficial. As a destroyer of insects the small Kauai Oo (*A. braccatus*), which is more specially adapted for climbing on the trunks of trees, is incomparably their superior. However at times I have seen *A. nobilis* leave the flowers of the Ohia to hunt amongst the foliage of a Koa in the more open forest, insects no doubt being the object of these visits.

The Molokai or Bishop's Oo (*A. bishopi*) does not greatly differ in its habits from the Hawaiian bird, except that in its case these habits are probably more natural, either because it was less hunted by the natives, or because it ceased to be persecuted long before the Hawaii species, owing to its diminished numbers. That it was hunted to some extent is certain from the fact that in the possession of an old native woman I found a large collection of the yellow feathers of this bird, some loose and some already tied in bunches with Olona fibre. That these had been obtained from birds caught alive and not shot was evident, as many feathers still showed traces of the bird-lime. Bishop's Oo is a great nectar-eater, and it visits the Lobeliaceae, or rather certain species of these, in preference to any other flowers. At times it may be seen numerously in the Ohia trees, when these are in flower, but this is clearly because its favourite lobelia nectar is unattainable. Thus on one of my visits to Molokai of about a score of the Oo that I watched while they were feeding, at a time when the Ohias and lobelias were both in flower, one only was seen to visit the former, though these were attractive enough to other birds. This Oo also visits the flowers of the banana in some of the deep gulches and valleys, and is said to also eat the fruit. To insect food, when the nectar of the lobelias is abundant, it pays little attention. Thus of ten shot at the lobelias and dissected not one contained a trace of insect food, although these were secured on different days and at very different times of day. On the other hand, the one mentioned above as visiting the Ohia flowers at this season contained a considerable amount of insect food.

When seen in the low brush of the Molokai forest the Oo is a somewhat inquisitive bird, but restless and timid when nearly approached, far more so than are most of the other forest birds that are found with it. It is easily called by imitating its cry, though it will not infrequently come and inspect the intruder uncalled. At such times the mixed timidity and curiosity of its nature are nearly always shown, and it rarely exposes itself to more than momentary view, diving beneath the foliage of the bushes at the

faintest alarm, and sometimes only thrusting out its head and neck from beneath the leaves to renew its inspection.

The cry of the Oo is unlike that of any other native bird, and no one who has once heard and identified it can ever again be in doubt as to the bird that utters it. This cry is usually dissyllabic, as represented by the bird's name, but sometimes may be represented by only a single sound. It varies somewhat, especially in loudness and clearness, according to the season, and is either uttered once or repeated. Thus at certain seasons the usual cry of the Molokai bird at its fullest was well represented by five syllables, '*owów, owów, -ów,*' the first and the second, as likewise the third and fourth, are practically continuous, with the stress on the latter in each case; there is a slight pause between the first and second pair of syllables and generally a longer and distinct one between the latter of these and the final one, which is extremely loud and might at times be almost termed a shriek. These cries are naturally audible at a great distance, and I have estimated that I have heard the cry of the Hawaiian species when half a mile from the bird, and that of *A. bishopi* is certainly sometimes audible at a distance of at least 3000 feet. When the former assemble in large numbers in the flowering Ohias, their cries are incessant, and are uttered not only from the trees but sometimes even on the wing, as the birds continually pass backwards and forwards from one tree to another. In fine weather they are mostly silent during the hotter hours, but in wet or foggy weather are often vociferous throughout the day. The Oo of Hawaii, apart from the cries above mentioned, has also a distinct song though it is extremely rarely heard, never uttered so far as I know from the tall Ohias, but always from some thick bush of the undergrowth. Contrary to what might be expected from the nature of its cry, this song is by no means loud. I have heard it only once or twice, even where the bird was very abundant.

The dwarf Oo, or Oo-aa, of Kauai as already mentioned differs considerably from its allies in its general appearance and structure, as well as in its habits and song. It retains to a considerable extent a like fondness for the nectar of flowers, whether those of the Ohia, the Lobeliaceae, or the banana. Its affection for the lobelias is often betrayed by their characteristic pollen sticking to its forehead, even when it is not seen in the act of visiting these flowers.

But it is in being much more largely insectivorous that it strikingly differs from its congeners, and in accordance with these habits its structure is somewhat modified. Thus while the long, weak plumes of the tail in the allied species are specially so modified for aesthetic purposes, in the Oo-aa they are stiff and pointed and aid it greatly when climbing on the trunks of forest trees, as is its common habit. Although its tail lacks the elegance of form, lacks too the special colour adornment of white tips, exhibited in some degree by the others, and has no yellow under-coverts for display, yet it retains the habit of erecting and flirting this, and indeed generally assumes postures similar to those of its more showy relatives. For insects it hunts freely on the trunks

of the largest Ohias, to which its powerful legs and claws aided by the stiff tail enable it to cling, woodpecker-like, while it searches on and beneath the bark. One's attention is frequently attracted to its presence by the rattling of large loose strips of the bark, beneath which it is seeking its prey. The food found in such situations consists of spiders, native cockroaches, the Prognathogryllid crickets, and the smaller ones of the genus *Paratrigonidium*, as well as some beetles and the larvae of these insects. Of course too it feeds on the ubiquitous Geometer caterpillars as well as on some wood-eating species, and unlike the Hawaii bird is very fond of the Koa trees, frequenting these even for choice in some localities. It is however abundant in forests where the Koa is wanting. Lesser forest trees it also visits, especially the Kalia (*Elaeocarpus*), so common a forest constituent on Kauai. This Oo is much tamer than the other species and is of a sociable disposition, little companies of from four to eight being frequently observed together, when all are fully adult. It also not infrequently joins the assemblages of insectivorous Drepanids.

The Oo-aa is always pleasant to hear, for its song though loud is very clear and melodious. Numerous as it is in many parts of the Kauai forests, in the early morning and again towards dark the woods fairly resound with its notes and the wild song of the even commoner Amaui (*Phaeornis*). Yet in these notes one can readily detect some resemblance to the cries of the other species of Oo, as though in the Kauai bird they were mellowed down and woven into song. The cry of the female when she is greatly alarmed is a mere reiterated squeak, utterly unlike her usual call, and would never be recognized at first hearing as belonging to any Oo. Nevertheless I have heard the Molokai species under similar conditions utter just such a cry, and I suspect that the female of the Hawaii species may do the same. My friend Mr G. C. Munro, if I remember rightly, once informed me that the Oo-aa both in its song and habits reminded him somewhat of the New Zealand 'Tui' (*Prosthemadera novae-zealandiae*), and the dark plumage of the Hawaiian genus likewise calls to mind that Meliphagine bird.

In forests consisting, so far as the large trees are concerned, almost entirely of Koa, I have often seen what is, no doubt, the nest of the Kauai Oo. These nests were always built in the topmost branches of these trees, and formed of dead twigs and dry phyllodes. They are of inartistic and flimsy construction, and when viewed from beneath the light usually shines freely through the interstices. Probably the other species of Oo will be found to build similar nests in the top of the tallest Ohia trees, as no doubt the Kauai species itself also does in many localities, only in the denser foliage of the Ohia it is almost impossible to detect them from below.

Even in recent years large numbers of the Oo of Hawaii have been caught with birdlime, after the manner of the old bird-catchers. Some of these were distributed on the other islands, and I was told that on Kauai they were still alive a year or two after they were turned loose. These birds are easily kept alive in captivity, and will live for a

considerable time on the juice of the sugar-cane, and probably for the natural term of their lives if freely supplied with their favourite nectar-producing flowers. They were habitually kept thus by the old-native birdcatchers to serve as decoys, as also were some of the Drepanididae, and are said to have become tame and reconciled to confinement.

(1) *Acrulocercus nobilis*, Merr.

HAB. . Hawaii in many and probably all the districts, but less numerous than formerly.

(2) *Acrulocercus bishopi*, Rothsch.

HAB. Molokai, both on the leeward and windward sides, but much less numerous than formerly.

(3) *Acrulocercus apicalis*, Gould.

HAB. Oahu formerly, probably extinct.

(4) *Acrulocercus braccatus*, Cassin.

HAB. Kauai, common and very generally distributed in the forests.

CHAETOPTILA Peale.

Native name *Kioea*.

The native name of *Chaetoptila* appears to have been the same as that applied to the bristle-thighed curlew (*Numenius tahitiensis*) but there is no reason to doubt the correctness of this name, which is applicable enough to either species.

There are very few specimens of this bird in collections, and it is now very probably extinct, the last that were obtained being, no doubt, those which were in the Mills collection, and which are now divided between Cambridge, Honolulu, and the Tring Museums. It is not known in what locality Mills' specimens were obtained, and although many of his species are supposed to have come from Olaa, it is very doubtful whether the *Chaetoptila* was found there. It is much more probable that it was confined to the high plateau between the mountains and the upper edges of the forest bordering this, where it was observed by Pickering and Peale of the United States Exploring Expedition. Here it frequented the flowers of the Ohia, apparently having much the habits of the Oo and a loud 'chuck' as its call.

(1) *Chaetoptila angustipluma* Peale.

HAB. Hawaii, perhaps now extinct.

Fam. FALCONIDAE.

The Falconidae are represented by three species only, and of these but one, the Hawaiian buzzard, is peculiar to the islands or of any special interest. The other two *Circus hudsonius* and *Pandion haliaetus* appear to be casual and more or less rare visitants, and I am not aware that either of these has been observed to breed in the islands.

Buteo Cuvier.

Native name *Io.*

The Hawaiian Buzzard or Io is restricted to the large island of Hawaii, whereon it has a wide distribution, and in several districts is far from rare. As is well known, it has two markedly distinct phases, a light and a dark one, which so far as I know are in nowise connected by true intermediate forms, and were they not said to interbreed, would have all the appearance of being distinct species. The individuals of these two forms are by no means evenly distributed over the large island. Thus in middle Kona all that I observed in two or three visits belonged to the light form, further north both this and the melanochroic form occur together, in Olaa and on the 1880 lava-flow above Hilo the 8 or 10 examples that I examined with the naked eye or field-glasses were all of the dark form. Mr H. W. Henshaw, however, has informed me that on windward Hawaii the light form also occurs. This ornithologist, who has paid much attention to the Io, and has amassed a large series of skins, has also informed me that the adult and immature plumages of the bird have been totally misunderstood by writers on Hawaiian birds, the supposed immature bird being really the adult. I have no doubt as to the correctness of Mr Henshaw's[1] observations, but am not at all surprised that the mistake should have occurred. In 1892 in Kona I found two or three nesting pairs of the Io at an elevation of about 3000 ft. above the sea, and each of these pairs was in the plumage which in Wilson's work is considered that of the adult. I did not see any nesting specimens of the bird with the white or pale buff head, but only solitary individuals, and should myself have considered these to be immature birds.

In Kona the range of the Io is from a hundred or two hundred feet above sea-level to 5000 ft. and perhaps higher. The nests that I observed were in each case built in a large Koa tree and at no very great height from the ground, and in such parts of the forest as lie within the rain-belt, from 2500—3500 ft. above the sea. When the young are hatched the parent birds are very bold and can hardly be scared away from their nests.

The Io is a gross eater, and many of those that I have seen have been so crammed with food as to be very unwilling, and one was apparently unable, to fly. At such times it frequently retires to rather dense cover, perching alone on one of the lower

[1] Since the above was written Mr Henshaw has published some notes on the Io in 'Ibis,' July 1902, p. 386.

boughs of a forest tree, and when intruded upon and closely approached, exhibits its concern only by such slight movements of the head as are necessary to keep an eye on the disturber of its rest. It is curious that, although I have by no means rarely come across the Io while thus resting, and in spots abounding in smaller forest birds, I never noticed that it was mobbed by the latter, as the owl sometimes is. Peale however says that small birds are its food, a statement which I am unable to corroborate, although on rare occasions it certainly does catch these. Mice are certainly a much more common food, and I have taken five full-grown ones from one bird, and from another four or five smaller ones and a large part of an adult Californian quail. Sometimes the Io contains no food other than insects and spiders, especially the large *Argiope avara* of the latter, and large caterpillars and larvae of large beetles (*Parandra* and *Aegosoma*) of the former class. In seeking the *Argiope*, the webs often stick to the legs and even other parts of the body, and dirt and other objects adhere to these and sometimes form a compact mass, with difficulty removed. In the Olaa district I caught an Io of the melanochroic form so weighed down in this manner, and its feathers so glued together, that it was unable to fly at all.

On account of its sluggish habits, conspicuous appearance, and slow flight the Io is not so common but that it might be exterminated comparatively easily, and indeed it has been slaughtered without just cause in some localities. It should rather be protected as a beneficial species, for it is far more useful than injurious. Like the crow at certain times it soars to an enormous height in the air and this fact renders the restricted range of both these birds all the more curious, as one would suppose that they would be, if not voluntarily, yet as a rare occasion and perforce, carried to the other islands and established there. This however appears not to be the case, and the occasional report of a hawk on Maui probably refers to one of the following species.

(1) *Buteo solitarius* Peale.

HAB. Hawaii in all districts; not rare and in some localities common.

CIRCUS Lac.

(1) *Circus hudsonius*, Linn.

HAB. Oahu, and probably other of the islands, as an occasional immigrant.

PANDION Sav.

(1) *Pandion haliaetus*, Linn.

HAB. Oahu as a stray, and I have heard it reported from Kauai and Niihau. Dole reports it from Niihau, Molokai, and Hawaii. I saw two examples of the Osprey on the coast near Waialua and one near Waianae in the winter of 1893–94. The latter may, however, have been the same bird as one of the other pair.

Fam. STRIGIDAE.

Asio Brisson.

Native name *Pueo.*

The Pueo or short-eared owl is the sole representative of its family in the Hawaiian group, where it is common on all the islands. Nevertheless it has decreased in numbers of later years partly owing to the increased area of land under cultivation, and partly because it is said to carry off young chickens and is consequently shot.

It is essentially a bird of the open country, frequenting chiefly the grassy slopes of the mountains below the forest, and the flat lands near the coast, but it visits the forest at times, even where this is moderately dense. I have more than once seen it in this situation, well within the forest on Haleakala, my attention being in each case attracted to its presence by the mob of small birds (chiefly the *Oreomyza*) which flocked around it with much chattering, but always keeping at a respectful distance. I have little doubt that it occasionally preys on some small bird, at such times as mice and rats are scarce. These latter are certainly its chief and usual food and have always been found in such birds as I have dissected. It is for these that the owl is hunting when it is hovering over the open grass lands, where mice are usually very abundant. In its habits it is both nocturnal and diurnal, for it may be seen on the wing in the brightest sunshine and heard in the middle of the blackest night. It is most active however as a rule in the early morning and in the latter part of the afternoon, when many individuals may be seen at the same time hovering at some distance from one another.

In the breeding season when the nest is approached the old birds will keep passing to and fro above the head of their disturber, and frequently follow him for a considerable distance. The eggs are laid on the ground amongst grass or Ilima scrub.

The short-eared owl of the islands is smaller in some of its measurements than are examples from other countries, and Bloxam's name of *sandwichensis* has been revived for these. Individuals of the island bird however exhibit no little variation in measurements, and even were this not the case, the distinctions between it and the others are so trivial as to hardly deserve a special name.

The short-eared owl is subject to the attacks of two parasitic[1] Hippoboscid flies, a larger and a smaller, one or both of which has been found on most specimens that I have shot.

In the old days the owl was not only very numerous but very tame. At the time of the discovery by Cook they are spoken of as 'owls which they have very tame,' which may perhaps mean that they were actually kept and tamed. At least we know that they were sacred, and the owl god one of considerable power, and by no means every native of the present day cares to kill one of these birds.

(1) *Asio accipitrinus*, Pallas.

Hab. All the islands. Very common in many localities.

[1] *Olfersia acarta* Sp. and *Ornithoica confluenta* Say, var. *peroneura* Sp. Vol. III. Pt II. p. 87 and p. 91 of this work.

Fam. CHARADRIIDAE.

STREPSILAS Ill.

Native name *Akekeke.*

The Turnstone is a regular migrant to the islands, arriving at about the same time as the Golden Plover, the two frequently forming mixed flocks. In its general habit it in many respects resembles the latter (q. v.).

(1) *Strepsilas interpres*, Linn.

HAB. All the islands; abundant.

CHARADRIUS L.

Native name *Kolea.*

The golden plover visits the islands regularly and in great numbers each season, after rearing its young in Alaska. The earliest immigrants usually arrive during the second or third week in August, at the same time as, and sometimes actually in company with, the Akekeke (*Strepsilas*), and both remain in the islands until the following April, when they return to their nesting-places in the North. Not all the individuals of either of these species however depart with the majority, a very small percentage of each remaining throughout the summer months. In 1893 I noticed several flocks of mixed Akekeke and Kolea throughout the summer months on Molokai, generally in company with the stilts, which frequented the mud-flats, and I have seen similar companies since on other of the islands. Certainly those that remain never breed in the islands, and they are mostly old and sterile or immature birds, since those that I examined had not assumed the nuptial plumage.

This plumage is at its finest, as also is their bodily condition, shortly prior to their departure to Alaska, but on their first arrival thence some still retain their black feathering.

When about to return to the North the Kolea frequently assemble in very large flocks and before setting out on their journey rise to an enormous height in the air, even beyond the range of sight. I have several times witnessed these departures, always late in the afternoon, or just before dark. I have once seen two such flocks start from the same point, the one following the other after an hour's interval.

In many parts of the islands large numbers of Kolea and of the Akekeke habitually resort to the margin of the sea and the extensive mud-flats for feeding purposes, but the greater part scatter over the low-lying grass lands and the open mountain country, where they may be found even as high as five or six thousand feet above the sea. In such localities they find abundant food in the caterpillars of various Noctuid moths, and indeed in the moths themselves. Of all the island birds the Kolea is beyond question

the most valuable to the grazier and the agriculturist, and it is singularly unfortunate that it is a most excellent bird for the table, and at the same time the one most generally sought after by sportsmen.

I have been at some pains to learn exactly the species of Noctuidae which form the favourite food of the plover, whether as moth or caterpillar, and I have several times shot the bird at the instant that it has seized a moth in its hiding-place at the roots of grass. I am therefore able to state positively that it catches the moth both of *Agrotis crinigera* and *dislocata*, the caterpillars of which are the two most extremely injurious and wide-spread of all the island 'cut-worms.' It also obtains the caterpillars of both these and other species and feeds as is well known to an enormous extent on the grass army-worm (*Spodoptera mauritia*), a caterpillar which not only locally entirely clears off the freshly-grown grass, but also does some damage to the young leaves of sugar-cane.

For these reasons the plover is worthy of all encouragement by the agriculturist and should never be shot on or around his land, or if this is done, he should not complain when his crops are ravaged by cut-worms, as is too often the case.

Unfortunately again for the agriculturist the plovers, which feed inland, are generally in the habit of repairing at intervals during the day to the ponds so frequently found near the coast, either permanently, or temporarily during the rainy season, and it is during these visits that the greater number are shot over decoys. Even the crudest imitation of the bird is sufficient to attract those that come to drink within easy range of the shooter, who sits behind a blind. In this manner they are generally shot as they hover or wheel around the decoys at a distance of from ten to twenty yards from the blind, and the execution by even a moderate shot is necessarily considerable, while very heavy bags are frequently made.

It is therefore not to be wondered at that the Kolea is much less numerous than was the case formerly, and it will certainly become still less so in the future.

(1) *Charadrius fulvus* L.

HAB. All the islands.

(2) *Charadrius squatarola* L.

HAB. Hawaii (Hewitt), as recorded by Henshaw.

Fam. SCOLOPACIDAE.

HETERACTITIS Stej.

Native name *Ulili.*

The Ulili is a common bird in many parts of all the islands, usually frequenting the sea-shore and the edges of shallow ponds near the coast, feeding on molluscs, crustaceans, and small fish. In some localities however it ranges far inland, as along

the course of the Wailuku river in Hilo district, where it may be found miles within the forest, as also in the large windward valleys of Molokai along the river-beds, and in similar localities on Oahu, Maui and Kauai. In these inland haunts those that I have examined were filled with the young of the Oopu and another small fish, and a pair of the birds are usually found together or not far distant.

(1) *Heteractitis incana*, Gmel.

HAB. All the islands; common.

LIMOSA Brisson.

(1) *Limosa baueri.*

HAB. Kauai (Gay); a casual visitant.

CALIDRIS Cuv.

Native name *Hunakai.*

(1) *Calidris arenaria*, L.

HAB. Most and probably all the islands. It is found on Niihau, and I have myself noticed it on Kauai, Oahu and Molokai. It is a regular visitant to the islands.

TRINGA Linn.

The two sandpipers named below, although they have been rarely noticed in the islands, are very likely not infrequent visitants.

(1) *Tringa maculata* Vieill.

HAB. Hawaii (Hewitt) as recorded by Henshaw.

(2) *Tringa acuminata* Horsfield.

HAB. Oahu (Judd); Maui (Newell).

GALLINAGO Steph.

(1) *Gallinago delicata* Ord.

HAB. Hawaii (Hewitt).

NUMENIUS Briss.

Native name *Kioea.*

The Kioea is found on most and probably all of the islands. I have seen it on Kauai, Oahu, Molokai and Maui, and it is found on Niihau. I did not observe it on Hawaii though it is no doubt there also. In some localities it is numerous, as in parts

of Molokai, where it forms large flocks, which feed both on the open uplands and on the mud-flats along the coast. These flocks are often accompanied by the Kolea and Akekeke, and like these most of the curlew depart for breeding purposes, a few stragglers only remaining in the islands. When it is not much hunted the curlew is unsuspicious, and by whistling its cry, which is well represented by the native name, it can easily be attracted, especially if at the same time a cap or other object be thrown into the air. As it comes flying up against the wind, its large size and slow flight make it an easy mark as it passes overhead.

(1) *Numenius tahitiensis* Gm.

HAB. Probably all the islands.

Fam. RECURVIROSTRIDAE.

HIMANTOPUS Brisson.

Native name *Aeo* or *Kukuluaeo*.

The Hawaiian Stilt is a common and widely distributed bird in the islands and in some localities is abundant. I have seen it on Kauai, Oahu, Molokai and Maui, and it is also found on Niihau. On Hawaii and Lanai I did not observe it, but on neither of these islands did I visit any very likely-looking localities. The Aeo is by far the most interesting of the Hawaiian shore birds, since it is quite peculiar to the islands, and abundantly distinct from its nearest allies elsewhere. It is generally abundant in places where the receding tide leaves extensive flats of black mud exposed, feeding on the worms and other marine creatures which are found in such places. Here it forms small flocks of varying number, but sometimes consisting of twenty or thirty individuals. It is also found commonly about the brackish or fresh-water ponds, which are found on the lowlands at a short distance from the sea, but keeps entirely to the plains.

It is in the neighbourhood of such ponds that it generally lays its eggs, frequently on ground much roughened by the trampling of cattle, as it often is in the vicinity of water.

The old birds are most solicitous for their eggs and young, and will fly over the intruder's head, darting down within a few feet of him, reiterating their harsh cries. By these cries other pairs are soon attracted, increasing the din and joining in the feigned attack; to draw attention from the young the parents will further feign death or disablement. Nor is it in the breeding-time only that one is thus assailed by these birds, for sometimes a small flock will behave in this manner at other seasons. When standing on the ground they have, when disturbed, a habit of bowing and nodding; and a small flock of the Aeo performing these antics together is a grotesque sight.

Some years ago the stilt was a familiar object by the sides of the railroad a few miles out of Honolulu, as one passed in the train, but it is now rarely seen there, for it was often shot by those in quest of other shore birds.

It also was common on the quarantine island close to the town and there is no reason why it should not still be so. On other parts of Oahu it is still abundant.

On Molokai it is at certain times very subject to the attack of a tapeworm, of which unfortunately I neglected to preserve any specimens.

(1) *Himantopus knudseni* Stejn.

HAB. Niihau, Kauai, Oahu, Molokai and Maui. Common.

Fam. PHALAROPODIDAE.

Phalaropes not infrequently stray to the islands and I have seen them on the coasts of Oahu, Molokai and Maui, generally singly and in company with the common shore birds. I never shot at any of these and am unable to identify the species, but the following two have been collected by others.

PHALAROPUS Brisson.

(1) *Phalaropus lobatus*, Linn.

HAB. Kauai (Judd and ? Munro). I am not able to identify from memory with any certainty the species of Phalarope obtained by the latter on Kauai, and it may belong to the following species.

(2) *Phalaropus fulicarius*, L.

HAB. Maui (Newell).

Fam. RALLIDAE.

PENNULA Dole.

Native name *Moho*.

The small native rail, now probably extinct, was formerly a common bird, and on Hawaii widely distributed, since it certainly inhabited both sides of the large island, and was as well known to some of the oldest natives on the lee side as to those on the windward. Whether more than one Hawaiian species was included under the name Moho it would be impossible to say, and I have here sunk the *P. millsi* of Dole, as a synonym of the old *Rallus ecaudatus*.

The Moho was, however, certainly not confined to Hawaii, though it probably survived there to a later date than on the smaller islands. Thus it certainly inhabited Molokai, and the late Mr R. Meyer, when I stayed with him in 1893, assured me that when he first came to that island (some 30 or 40 years before) it was well known to the natives, and they even offered to catch specimens for him. Unfortunately at that time

he took no great interest in the matter, which, as he told me, he much regretted afterwards. Not only did some of the Molokai natives quite recently know of the former existence of the bird on that island, but they still remembered and could imitate its cry, and further stated that the Moho were of two kinds some being 'redder' than the others. Now as nothing is known as to the sex or age of the few preserved specimens of Hawaiian Rails it is certainly far safer to consider these as belonging to a single species; for it is scarcely credible that two inhabited the same part of the small island of Molokai, while there is little doubt that the Molokai birds exhibited considerable individual difference, at least in colour. I obtained some evidence of the former occurrence of the Moho on other of the islands, but not with the definite information supplied on Molokai. It is more than likely that it was once found on all.

Both on Hawaii and Molokai the Moho frequented the open country below the continuous forest, and the open country covered with scrub that lies within the forest belt. Its last home on Hawaii appears to have been the rather open country which lies just outside the heavily timbered part of the Olaa district on the smooth or pahoehoe lava, and the country between the same heavy forests and the crater of Kilauea. There is little doubt that the specimens formerly in Mills' collection came from one or other of these two neighbouring localities. It is possible but not probable that the Moho still exists there.

In olden times the Moho and the small native rat (whatever species that may have been) shared the distinction of providing sport for the chiefs, who hunted them with bow and arrow. Indeed the Moho appears to have lived on friendly terms with these rats and is said to have even been in the habit of hiding itself in their burrows in times of danger. As the introduced mongoose in 1894 was already conspicuous in the last known haunts of the Moho, there is small hope that this flightless bird still exists.

(1) *Pennula ecaudata*, King.

HAB. Hawaii formerly; and this or allied species also once inhabited some of the other islands.

GALLINULA Brisson.

Native name *Alae ula.*

The Alae ula is generally distributed over the islands in suitable localities, often frequenting the rice fields and taro patches. It does not appear to follow the streams into the mountains, even where they seem quite suitable, the cover on the banks being abundant, and small fish, crustaceans and other food beyond its needs. I have dropped the specific name '*sandvicensis*,' as there appear to be no characters to distinguish the Hawaiian bird even as a constant variety. The colour of the tarsus varies in the amount of its redness and sometimes is not red at all.

Like the Buzzard, the Owl and many other birds the Alae ula figures largely in legends, and from this one would infer that it is at least a moderately old inhabitant of the Hawaiian group, and might be expected to show in its isolated island home greater distinctions from typical examples than it does. That it does not do so, may be due to the fact that it is less susceptible to change of environment than are most birds, but at the same time we have no proof whatever as to the complete isolation of the island Gallinules, and it may be that at intervals stragglers from outside arrive in the islands and interbreed with those already here.

(1) *Gallinula galeata*, Bon.

HAB. All the islands on the lowlands.

FULICA L.

Native name *Alae keokeo.*

The Coot is less widely distributed than the Gallinule although it probably exists in some localities on all those islands which possess ponds of any considerable size, in the neighbourhood of the coast. I saw it commonly on Kauai, Oahu, Molokai and Maui frequenting ponds of either fresh or strongly brackish water, as well as on the larger streams at a short distance from the coast.

On many of the shallow brackish ponds which are devoid of a fringe of rushes or of any vegetation, the nests are often built in the water far from the edge, and consist of a large pile of sticks and twigs, resting on the mud and rising well above the surface. The material in such a nest where the water is two feet deep is very considerable and frequently consists of the branches and twigs of the Algaroba or any other tree that grows near the pond. In less open localities and where aquatic vegetation is abundant, rushes, grasses and sometimes the leaves of the *Pandanus* provide material for the nest.

The coot forms flocks of considerable size and I have seen fifty or a hundred together on a fair-sized pond. When many foreign ducks arrive, the Alaes are on some ponds inclined to keep to themselves, and though strong on the wing they are less willing to leave the water than the ducks. If compelled to do so by one's wading in from the sea side they will pass overhead affording some pretty shots, and generally in the absence of other ponds alight a considerable distance out at sea, but within the reef On less open waters they are generally much tamer and may even with due care be watched at a very short distance, as they hunt for food along the edges of the thick rush beds.

Occasionally the frontal shield instead of being white is of a rich dark chocolate-brown colour. I shot one such specimen on Oahu in 1892 and have seen others since.

Whether this variation is due to age I do not know, but the natives called it by a different[1] specific name.

(1) *Fulica alai* Peale.

HAB. Most of and probably all the islands; common.

Fam. ARDEIDAE.

NYCTICORAX Rafinesque.

Native name *Aukuu*.

The Aukuu is a very common bird and is found on all the islands. It is even seen in the town of Honolulu, and one or more were frequently noticed resting in the daytime in the tops of the mango or tamarind trees which grew in the garden of one of the city hotels. Though it sometimes feeds during the daytime it more usually rests during the heat of the day and till near dusk, either in the top of some tree with dense foliage or standing in or near some pool of water, or on the mud-flats of the coast. It follows the mountain streams far inland feeding here, as elsewhere, on small fish. The heronries of the Aukuu often contain many nests and are sometimes found near the coast in the Lauhala trees (*Pandanus*), but more often from four to seven miles inland in the groves of Kukui (*Aleurites*) which flourish at 1000 ft. or more above the sea, by the side of the mountain streams. In one such heronry that I examined on Oahu in March the young were already all hatched.

(1) *Nycticorax griseus*, Linn.

HAB. All the islands; abundant.

ARDEA Linn.

(1) *Ardea sacra* Gm.

HAB. Recorded by Dr Finsch who saw it on Maui. Dole's remark that it is common all over the group of course refers to the preceding (*Nycticorax*).

Fam. IBIDIDAE.

PLEGADIS Kaup.

(1) *Plegadis guarauna*, L.

HAB. Kauai (Knudsen), Molokai (Munro), and also reported from Maui. A chance, but probably not infrequent, visitor, since very small portions of the coasts are examined each year, and even these far from systematically. The bird has been described to me more than once by casual observers.

[1] The Alae awi is known to natives of Oahu, Molokai and Maui; it differs from the Alae keo as follows: frontal shield dark rich chocolate (redder after drying), beak white but the lower mandible with two red-brown spots, which are separated by a bright yellow line, a little behind the tip; the upper mandible has a single transverse red-brown spot placed above those on the lower. Legs down to and including the basal joint of toes bright apple green in front, except the joints themselves.

Fam. ANATIDAE.

There are five geese and twelve ducks known to have occurred in the Hawaiian islands proper, but of these 15 are either regular or casual visitants and are of little interest. No doubt this list (which can be depended on) will be further[1] increased, some of the species here mentioned, not previously recorded from the islands, having been noticed by several of the more observant sportsmen. A list embracing nearly all the species here included has been kindly furnished me by Mr S. G. Wilder.

ANSER Brisson.

(1) *Anser albifrons* var. *gambeli* Hart.

HAB. Hawaii (Palmer).

CHEN Boie.

(1) *Chen hyperborea*, Pall.

HAB. Maui (Newell); also known on Oahu.

BERNICLA Steph.

Native name *Nene.*

The Nene is widely distributed on the island of Hawaii and in some localities is a fairly common bird, and it is said to have formerly frequented Haleakala, Maui, although neither in my many visits to the summit, nor when camping in the bottom of the great crater, did I myself get sight of one. From the fact that parts of the crater as well as much of the higher slopes of Haleakala are extremely similar to some of its favourite haunts on Hawaii, and produce also some of its favourite food in abundance, its scarcity on Maui at the present time (if indeed it still exists there at all) is remarkable. The other islands are quite unsuited to its natural habits, and it is not found on these, though stray foreign geese are often mistaken for it.

As is well-known the Goose, like many other native birds, changes its abode at different seasons of the year, being no doubt chiefly influenced by the food-supply. In the summer months it affects the open upland region, which is covered with a scrubby vegetation and traversed by many lava flows, such for instance as parts of the plateau between the three great mountains of Hawaii, at an elevation of four or five thousand feet above the sea. Near the crater of Kilauea about two miles from the Volcano House hotel flocks of some size may be occasionally seen in the later summer. In such situations it feeds on the abundant Ohelo berries (*Vaccinium*), on the wild strawberry (*Fragaria chilensis*), where the cattle still allow this to exist, and still more commonly on the black berries of the creeping *Coprosma*, one of the commonest plants in some of its favourite localities. In the winter months large numbers of these upland

[1] The Emperor Goose (*Philacte canagica*) has now been added by Mr H. W. Henshaw (Auk, Vol. xx. (1903), p. 164).

geese resort to the lowlands and remain there for such time as the vegetation is fresh and green, and they are said to breed during this season. I have not been able to learn that the Nene ever visits the brackish or other ponds of the lowlands, as do stragglers of foreign geese, which are often mistaken for it; and in many of its upland haunts it certainly seems to avoid the wetter and more marshy localities. In captivity however, it sometimes acquires a very decided liking for water and will enter it readily enough.

Like so many other members of the native Avifauna, the goose is becoming less common than in former years, and unless stringently protected at all seasons will probably become extinct. Its extinction would be a source of much regret, for apart from the scientific interest attached to the bird, its appearance is striking and beautiful, and it is highly characteristic of some localities, themselves remarkable, and almost or quite untenanted by other native birds.

(1) *Bernicla sandvicensis* Vig.

HAB. Hawaii; widely distributed. Also said to inhabit (or to have inhabited) Haleakala, Maui, but the specific identity of the birds from the two islands is not proved.

BRANTA Scop.

(1) *Branta canadensis* var. *minima* Ridgw.

HAB. Kauai (Palmer).

(2) *Branta nigricans* Lawr.

HAB. Maui (Newell).

OBS. Brant geese are frequently met with on one or other of the islands during the winter months. During the period of my collecting in the islands I myself noted or was informed of stragglers or flocks of these birds on all the islands excepting Lanai and Niihau, but the species were not identified.

ANAS L.

(1) *Anas boscas* Linn.

HAB. Oahu, Molokai and probably the other islands, as a straggler amongst the flocks of common migratory ducks. On the latter island one was shot by me casually amongst a very large flock of shovellers. Schauinsland has reported it also from the outlying island of Laysan.

(2) *Anas wyvilliana* Scl.

The Koloa maoli or true native duck of the islands is a most interesting species, and it is remarkable that it has received scant attention from the resident ornithologists

—the more so as it is common enough on nearly all the islands. I have noticed it plentifully in many localities on Kauai, Oahu, Molokai, Maui and Hawaii, in fact on all the islands visited by me, excepting Lanai, but in no one locality have I been resident sufficiently long to make out satisfactorily the connection between the very different varieties that it presents. The extreme forms represented are so very different, that at first sight they might readily be mistaken for distinct species, but they are certainly connected by intermediate examples.

It is hardly possible to doubt that *A. wyvilliana* is a dwarfed descendant of *A. boscas*, which in many respects it so much resembles, and to which it is certainly more nearly allied than to any other species (excepting perhaps the still smaller Laysan duck (*A. laysanensis*), which I have not had an opportunity of examining). Thus the voice of the Koloa is quite that of the mallard, excepting that in accordance with its lesser size it is less loud. So too the full-plumaged drake has the recurved tail-coverts like those of the male *boscas*—at least in some individuals. If however many specimens of the Koloa be examined when paired either prior to, or during the breeding season, it is evident that by no means all the drakes possess these recurved feathers, and further that there is much individual variation in the amount of modification of the tail-coverts, some showing only a slight trace of this. Perhaps not more than one in seven of the adult drakes have the tail-coverts conspicuously modified.

As the common mallard is now occasionally, though rarely, found in the islands and even reaches the still more remote island of Laysan, it at first sight would appear unlikely that the native duck could be a descendant of that species, for the occasional arrival of fresh individuals would do away with any true isolation. It must be remembered that if a mallard is now on rare occasions killed or noticed, we can be sure that its occurrence in the islands is not very infrequent, because, as I have previously stated, the islands are very incompletely and irregularly searched for stray specimens of foreign birds. Such mallards as are now occasionally noticed, appear to be simply stray birds amongst the large flocks of regular migrant foreign ducks. It is therefore probable that the native duck was descended from certain stray mallards which reached the islands by some remote chance at a time long prior to the regular winter immigration of shovellers and pintails, which now naturally enough bring an occasional mallard with them. Indeed one would surmise that a very long period of isolation would have been necessary for it to acquire its specific distinctions, when one considers the enormously wide and varied range that the parent *boscas* occupies without noticeable variation. Whether these immigrant mallards of the present day ever remain in the islands to interbreed with the native duck is uncertain, but it is much more probable that they invariably return with the flock in company with which they came to the islands. I cannot find that a mallard has ever been seen except in such company and in the winter season. If the native duck interbreeds at all (and the variability of the species has led to some suspicion of hybridism) it is far more likely to do so with the

domestic duck, in company with which I have occasionally seen it in the rice fields and elsewhere. For my own part I believe the individual differences exhibited by the Koloa to be simple variation, such as is frequently shown even in a far more striking manner by other creatures, which like the duck are the sole indigenous representatives of their genus in the islands.

As to its habits the Koloa is equally at home on the hottest coasts, where suitable ponds are found, or in the mountains, where I have noticed it as high as seven or eight thousand feet above the sea-level. In the uplands it chiefly affects the mountain streams, whether flowing through open country or heavy woodland, and may be seen in some numbers on small ponds, where these are found. Not infrequently it is to be found in boggy parts of the forest, which are quite heavily timbered, frequenting the tiny pools of water that collect in hollows in such situations. Along some of the larger streams, which flow through heavy forest, the Koloa breeds regularly, as also about the ponds on the lowlands adjoining the coast. It is very irregular in its nesting time. In some localities at an elevation of 4000 ft. the flappers are in fine condition in August. On New Year's Day 1893 I flushed and shot a duck and drake near the coast at Waialua, and, when I went to gather them, I found that they had already hatched a large brood of young. The majority of native ducks, however, breed between March and June. Even in the precipitous mountains many scattered pairs frequent the small pools that form at the foot of waterfalls, temporary or otherwise, leaving these haunts at night-fall to visit the rice and taro patches of the valleys below. Such individuals when shot, frequently have their crops filled with the ripe grains of rice. They are also very partial to the various kinds of molluscs frequenting fresh or brackish water, to the larvae of dragon-flies and such other animal or vegetable food as is accessible to them.

Though small the Koloa is a good bird for the table and is yearly shot in great numbers by sportsmen, chiefly about the ponds on the plains, but to some extent in the mountains also. On the mountain streams it is generally tame and as it rises slowly from the water and in easy range it affords the easiest of marks. For this reason and because many of its haunts are overrun with the introduced mongoose, it is in some localities becoming much scarcer than formerly and in others has practically disappeared.

As has been above stated the voice of the Koloa is that of a mallard and it has the same habit of quacking loudly as it rises from the water.

HAB. All the islands where are ponds or streams.

MARECA Steph.

(1) *Mareca americana*, Gm.

HAB. Oahu and Maui; as a straggler with the other immigrant ducks, also recorded from Laysan.

QUERQUEDULA Steph.

(1) *Querquedula carolinensis*, Linn.

HAB. Known to sportsmen as an occasional visitant.

SPATULA Boie.

(1) *Spatula clypeata*, L.

HAB. Most and probably all the islands; common.

DAFILA Steph.

(1) *Dafila acuta*, L.

HAB. Most of the islands with the preceding; common.

CHAULELASMUS Bonaparte.

(1) *Chaulelasmus streperus*, Linn.

HAB. Oahu; noticed by sportsmen as rare immigrant.

FULIGULA Steph.

(1) *Fuligula marila*, L.

HAB. A stray visitant like the preceding.

(2) *Fuligula vallisneria*, A. Wilson.

HAB. Another stray visitant.

CHARITONETTA Stejn.

(1) *Charitonetta albeola*, L.

HAB. Oahu, Maui; also recorded from Laysan.

MERGUS L.

(1) *Mergus serrator* L.

HAB. Several of the islands, well-known to some sportsmen.

Fam. FREGATIDAE.

FREGATA Cuv.

Native name *Iwa*.

(1) *Fregata aquila*, L.

HAB. Several and probably all of the islands occasionally. It breeds abundantly on the outlying island of Laysan.

Fam. SULIDAE.

SULA Br.

(1) *Sula fiber*, L.

HAB. Niihau; and probably other of the islands occasionally.

(2) *Sula piscator*, L.

HAB. Niihau, Kauai and Oahu; and probably at times on the other islands.

Fam. PHAETHONTIDAE.

PHAETHON L.

Native name *Koae*.

(1) *Phaethon lepturus* L. and D.

The Koae is an abundant bird on all the islands, nesting freely in the precipitous cliffs bounding the valleys and larger gulches, and it may often be seen in the daytime flying around in the vicinity of its nesting place. Sometimes however the nest is formed in less inaccessible places, as on the sloping side of a large gulch, and can be examined without any actual climbing. The birds are not rare even in the immediate neighbourhood of Honolulu, and in southerly storms their harsh cries are frequently heard overhead in the city itself and in the neighbouring valleys during the hours of night.

(2) *Phaethon rubricauda*, Bodd.

HAB. Niihau, Kauai, Oahu, Hawaii; and probably the other islands. The red-tailed Koae in the main islands of the group is much rarer than the preceding species. It becomes much more abundant on some of the islands to the north-west of these, nesting freely there.

Fam. PROCELLARIIDAE.

OESTRELATA Bon.

Native name *Uau*.

(1) *Oestrelata phaeopygia* Salvin.

The Uau is common in many parts of the islands, nesting in the high mountains, where it forms large colonies. The young were formerly killed in great numbers by the natives, who pulled them from the burrows by means of a stick split at the end, which was twisted in the down, just as rabbits which refuse to bolt are sometimes extracted by the fur. The old birds also were captured in nets as they returned from

the sea inland, the hunter calling them nearly to the ground as they passed overhead in the dusk. Apparently when rising from the downward swoop, which followed the hunter's call, they became entangled in a large spread-net, but accounts vary as to the method employed. As the Uau in returning from the sea generally follow the same course, a spot in the line of flight was selected, and their capture was rendered comparatively easy.

HAB. All the larger islands. Common locally.

BULWERIA Bon.

(1) *Bulweria bulweri* J. and S.

HAB. Kauai, Hawaii; and no doubt other of the islands.

PUFFINUS Br.

(1) *P. cuneatus* Salvin.

HAB. Kauai; and probably on other of the islands. It is known to the natives as Uau kane.

(2) *P. newelli* Henshaw.

HAB. Kauai, Maui, Molokai; and probably the other islands, where are deep valleys with precipitous sides.

OBS. I once found several dead and partially decayed specimens of this bird at the head of one of the deep valleys of windward Molokai some days after a severe storm. Near the top of the precipitous cliffs at the side of the valley the natives informed me that there were extensive colonies of a petrel (which they called Uau) at the nesting season. It is quite probable that these were really the present species, though they may have been the true Uau (*Oestrelata*).

OCEANODROMA Reich.

(1) *Oceanodroma cryptoleucura*, Ridgeway.

HAB. Not rare on Kauai, where it has been collected by Messrs Gay, Knudsen, Munro and others, and it will no doubt be found on the other islands.

Fam. DIOMEDEIDAE.

The two following species of Albatross are found in the main islands of the group only as stragglers, *D. immutabilis* breeding in countless numbers in the outlying islands to the north-west.

DIOMEDEA L.

(1) *Diomedea nigripes* Aud.

HAB. Occasionally noticed on some and probably found on all the islands.

(2) *Diomedea immutabilis* Roths.

HAB. Several and probably all the islands.

Fam. LARIDAE.

STERNA L.

(1) *Sterna fuliginosa* Gmel.

HAB. Kauai, Oahu; and probably the other islands.

(2) *Sterna lunata* Peale.

HAB. Kauai; probably on the other islands.

(3) *Sterna melanauchen* Temm.

HAB. Kauai (Judd); and will probably be found as a straggler on other of the islands.

ANOUS Leach.

Native name *Noio.*

(1) *Anous hawaiiensis* Rothsch.

HAB. All the islands, and in many places abundant.

(2) *Anous stolidus* L.

HAB. Oahu; and no doubt other of the islands.

GYGIS Wag.

(1) *Gygis alba* Sp.

HAB. Recorded by Dole, probably correctly, as it is known to inhabit the islands to the north-west of the group. I can think of no known Hawaiian bird more likely to be the "white pigeon" reported by Cook's men than this tern.

LARUS L.

(1) *Larus barrovianus* Ridg.

HAB. Kauai, Maui; and probably other of the islands.

(2) *Larus glaucus* Br.

HAB. Hawaii (Henshaw).

(3) *Larus philadelphia* Ord.

HAB. Kauai (Palmer); a single stray specimen.

(4) *Larus californicus* Lawr.

HAB. Maui? (Newell); a single stray specimen obtained.

(5) *Larus delawarensis* Ord.

HAB. Maui? (Newell); a single stray specimen obtained.

(6) *Larus franklini* Sw. and R.

HAB. Maui (Newell). A casual visitor, once obtained.

OBS. Gulls are not infrequent on the coasts of Oahu during the winter months, but none appear to have been collected on this island. I have also several times seen them on other of the islands, always singly or in pairs. Their occurrence is of course accidental and of little importance, and the same remark might be made of many of the shore-birds, ducks &c. No doubt the list of these casual visitors may be considerably increased with an increase in the number of resident observers. That the list is as long as it is is due very largely to Mr Francis Gay and the late Mr Knudsen of Kauai, to Mr Henshaw of Hawaii, and Bro. Matthias Newell, so long resident on Maui, and to some observant sportsmen. For the visiting naturalist the sea and coast birds possess little attraction, and while Drepanididae and Meliphagidae remain in the mountain forests, the former will naturally receive scant attention from such an one.

MAMMALIA.

At the time of the discovery of the islands by Capt. Cook a few species of mammals were found established in them. A rat (*iole*) and perhaps a mouse, a peculiar breed of dog (*ilio*), one (or perhaps two) species of bats (*opeapea*) and a hog (*puaa*) made up the list. Since that time other rats and mice, domestic mammals of various kinds, other species of bats, and the mongoose have been imported, either accidentally or for special reasons. An Asiatic deer, unwisely imported into Molokai, has played havoc with the forest on that island, and it became necessary to employ skilled hunters to check its excessive increase. The mongoose was (as in other countries) imported for the extermination of the foreign rats, which ravaged the fields of sugar cane. By some it is said to have been of considerable benefit, but it is noteworthy that while the plantations of Kauai formerly suffered extremely from the plague of rats the mongoose was not taken to that island. Yet at the present time I am unable to learn that rats are a greater pest on Kauai than on islands where the mongoose has been

established; and hence it is probable that the decrease in numbers of the rats was by no means due to the mongoose, but to some cause which affected all the islands alike, whether the mongoose was or was not present. The bats, imported for special purposes, appear to have all died out. The small species (*Lasiurus semotus* Harrison Allen), frequenting the mountains, is common locally in the uplands of Hawaii, and I have seen it, though very rarely, on Kauai and Oahu. It very seldom visits the lowlands and probably only when driven down by stress of weather.

The rat is supposed to have been a peculiar species, but no evidence exists on this point. It was quite small and is now probably entirely driven out by the common grey and black rats, introduced by ships. Shooting these native rats and the flightless rail (*Pennula*) with bow and arrows appears to have been a favourite sport of the chiefs. The imported rats now abound in many parts of the forest and lead largely an arboreal life, feeding on such fruits as are to be had, especially that of the Ieie (*Freycinetia*) and the mountain apple (*Eugenia*) and on the brightly coloured arboreal molluscs of the genus *Achatinella* and the duller ground-frequenting *Amastra*. Mice abound throughout the grass-lands and form a large part of the food of the short-eared owl. They appear[1] to have been present before the arrival of Cook, but it is by no means certain that the species, now so numerous, is the same as the former inhabitant, and it may be that the latter like the native rat has been supplanted by the common foreign mouse.

The dog, as stated above, was of a peculiar breed and was used for food. It was fed largely on 'poi,' the paste, prepared from the taro, which formed the chief food of the natives. The poi-dog is now a thing of the past.

On the whole it is probable that excepting the bat (*Lasiurus semotus* Harrison Allen), which was a natural immigrant, all the mammalia existing at the time of the discovery were brought by the natives themselves, or in the case of the mouse and rat, these may have been escapes from ships wrecked on the coasts.

[1] There is some doubt on this point. Certainly they were abundant in 1825.

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