THE POLYNESIAN FRUIT PIGEON, *GLOBICERA PACIFICA*, ITS FOOD AND DIGESTIVE APPARATUS.

BY CASEY A. WOOD.

IT was probably John Murray (*Proceedings of the Zool. Soc.*, p. 737, 1877) who first drew attention to the unusual anatomical construction of the gizzard of *Carpophaga* [*Globicera*], as shown in two specimens of *C. latrans* taken on Kandavu, Fiji, during the voyage of the 'Challenger.' His notes on this subject are, in part, as follows:—"Stomach contained the fruit of some tree unknown to me. The coat of the stomach had hard papilla-like ossifications of a circular form arranged in two or three rows." The material was submitted to A. H. Garrod, Prosector to the London Zoological Society, whose report (*Proc. Zool. Soc.*, 1878, p. 738) furnishes interesting reading. Of the digestive apparatus he remarks that the thin-walled and capacious crop contained only one object, a complete fruit, subsequently identified as that of *Onocarpus vitiensis*, one of the *Anacardiaciae*. Parenthetically this tree, as described by Seeman (*Flora Vitiensis*, p. 176), is 60 feet high, with large, oblong leaves and a curious fruit, somewhat resembling the seed of a walnut. Garrod pointed out that for the attrition and crushing of this hard and compact nut and its capsule a modification of the gizzard-walls of this Fruit Pigeon has been necessary, although the organ itself is not developed to anything like the extent one notices in *Gallinae* or *Anseres*, but is small, and has its muscular walls comparatively thin. For effective grinding of the ingested food the bird depends upon quite another agency, as set forth by Garrod in describing the stomach mucosa:—"Instead of being smooth, or plicated, as is usually the case, its surface is raised into horny cones which closely resemble in appearance the tubercules for the attachment of the spines of the echinoderm *Cidaris*." He further describes these conical processes as horny, erect and transparent when sectioned. The diameter of the larger (and more numerous) averaged 7 mm. at the base; their height was about 4 mm. The smallest cone was as high as the largest (and

consequently more pointed), its basal diameter being only 4 mm. The cones were arranged on the muscle-masses in regular fashion, and were close to one another. Of the 23 found in each specimen, 18 were disposed in rows of three, whether counted longitudinally or transversely. The remaining five were placed "on the tendinous, intermuscular walls of the organ in longitudinal rows, two in one row, three in the other." The illustrations supplied by Garrod show that the cones do not contain osseous tissue but are corneous throughout, and of the density of ox-horn. "The attached surface of the epithelium does not participate in the undulations of the free surface, being quite smooth."

The mucous lining does not send any processes into the cones proper; between the latter it is yielding and, says the report, is only semicorneous. The article quotes a description of a somewhat similar condition found by Verreaux and Des Murs (*Revue et Magasin de Zoologie*, p. 168, 1862) in the gizzard of *Phoenorhina goliath*, but in that bird the cones are larger than in *C. latrans*. They were also ossified and obliquely placed, the remains of the vessels of ossification appearing as a central fibrous peduncle in each cone.

A remark of the writer in the 'Challenger' report is indirectly responsible for this short paper:—"I am informed that *Carpophaga* [*Globicera*] *pacifica* in the Samoan Islands feeds on nutmegs, from which it is highly probable that in the species the gizzard-epithelium is modified in a manner similar to that of the Fiji or New Caledonian species. Specimens of *C. pacifica* would therefore be of special interest for the determination of this point." During a residence of several months (May–November, 1923) in the former Group, with excellent opportunities to study Fijian bird life, the present writer dissected twenty-one specimens of *Globicera pacifica*, mostly from Viti Levu, and found the intestinal tract much the same as that partially described by Garrod in *C. latrans*.

The stomach and duodenum held, in the majority of instances, partially digested food; in four, both oesophagus and gizzard were empty. In two cases the gizzard and lower intestine were empty, while the crop held one or two unchanged fruits. In 16 instances the stomach or other part of the digestive tract contained one variety of the wild nutmeg. Indeed where nutmegs were obtain-

able this Fruit Pigeon appeared to live on them exclusively; it seemed that other fruits were swallowed only when there were no nutmeg-bearing trees in the neighborhood. As a rule the gizzard contained a single fruit; in a few instances there were two, and in one specimen the stomach held two large nutmegs while the oesophagus was distended by two others. It is readily seen that the local English name—Nutmeg Pigeon—given this bird is entirely justified.

The following field notes of nine *post mortem* examinations will serve further to emphasize the character of the food ingested by this species:—

July 18, 1923. In the gizzards of eight specimens of *Globicera pacifica* there were 13 wild nutmegs (*Myristica castanaefolia*) and a drupe that resembled the fruit of a small cherry. Two stomachs were empty, one held a single nutmeg with no traces of the pericarp; five held two nutmegs, one quite large; another had two of the largest nutmegs as well as a second drupe of the species aforementioned and unknown to me. In two stomachs there was a "matting" composed apparently of the undigested pericarp lying between two small-sized nutmegs.

August 12, 1923. Took from the gizzard of a Nutmeg Pigeon at Vunisea, Kandavu, a large quantity of softened and disintegrated mace, and with this inspissated arillus a wild nutmeg 32 mm. long and 29 mm. wide.

No gravel or sand was found in any of these gigeria. In two instances a gritty substance was felt between the thumb and fingers, but the ingestion of small quantities of earth may easily be explained by the fact that these pigeons occasionally pick their food from the ground.

There are at least four species of the genus *Myristica* growing wild in Fiji, all of which furnish food to the "Soqi" or Nutmeg Pigeon. The commonest of these is *M. castanaefolia,* found in all the larger islands as a handsome tree 60–80 feet high. The mature fruit is as large as a full-sized butternut which it resembles, both as to testa and pericarp. Some writers assert that settlers in Fiji use the kernel of one species as a substitute for the nutmeg of commerce—*M. moschata.* It has the shape and size of the latter, and the color of the aril or "mace" is similar, but its aromatic properties

are not well developed. The present writer investigated this matter and found that the wild Fijian nutmeg, exhibiting as it does only a suspicion of the characteristic, spicy odor and taste, is rarely used as a condiment either by Europeans, Indians or aboriginals. Moreover, several attempts to export the most promising of the species failed as a business speculation. *Globicera* has also a liking for the small fruit of the Banyan Fig (*Ficus bengalensis*) of which it eats sparingly and when nutmegs are not available. The writer has found the remains of these in the gizzard of three specimens.

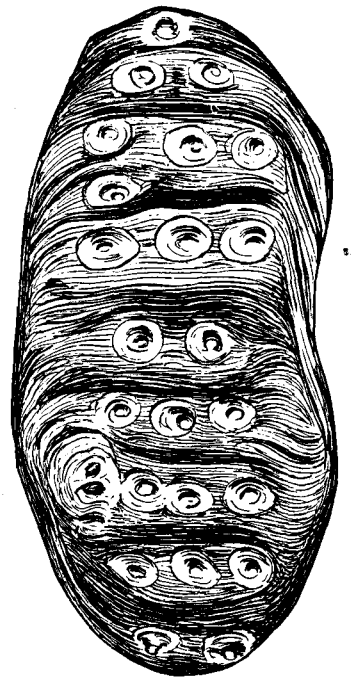
H. B. Guppy (*Observations of a Naturalist*, p. 403, 1906) notes that species of two other floral genera—*Canarium* and *Elaeocarpus* —furnish food for Fruit Pigeons. Of *E. graeffei*, he found the stone in this pericarpal fruit measure 3–5 centm. Of Canarium, with its large drupe, the "pit" was 2 cm. in length. The distribution of this tree in Fiji is mostly by Fruit Pigeons, in whose crop Guppy found fruits measuring 25 × 28 mm.

Seeman also mentions the drupes of *Couthovia corynocarpa* as part of the dietary of the Fruit Pigeons of Fiji.

Of course the part played by the gizzard in the mechanics of the digestive function in this Fruit Pigeon is made quite plain by dissection. None of the hard parts of the nut are crushed or macerated, as one might conclude from some writings on the subject. That portion of the fruit actually digested is in all instances only the soft, outer coverings especially the nutmeg arillus; the woody testa with its contents pass through unchanged, while the aril with, rarely, the pericarp, is ground off the inner shell and reduced to pulp by the action of the horny processes, set in the contracting and expanding muscle layer of the gizzard, before it passes into the lower intestine. This explains, by the way, the wide distribution of *Myristica*, and perhaps of some other species, whose fruits, the chief diet of these Pigeons, are planted far and wide over the Islands.

It is difficult to believe that the throat and gizzard of *Globicera* can permit the passage and retention of such large masses as are not infrequently found in the oesophagus and stomach; indeed it is a question how large a fruit this pigeon *can* swallow. Occasionally a bird manages the entire mass of one of the smaller nutmegs,

pericarp and all, but as a rule only that portion of the fruit freed of its outermost covering is swallowed. Many entire, wild nutmegs are so large that one may confidently assert that they could not be swallowed by even the most expert bird. For example, the writer obtained from a *Myristica* near Tamavua Station, Viti Levu, many fruits in all stages of development. These were, as



INNER SURFACE OF GIZZARD OF POLYNESIAN FRUIT PIGEON.
Actual length 2.50 ins.

usual among nutmegs, borne in pairs, and the irregularly rounded bilobed pericarp of the largest measured 16.3 cm. in its smallest and 17.5 cm. in its largest circumference. On section the stone measured 12.5 × 25 mm. with the arillus in place. The pericarp closely resembled the outer covering of our butternut, was very thick and tough and not easily cut even with a sharp knife. It did not, however, stain the fingers. In this collection were also numerous small, immature nutmegs, but none of them gave out the characteristic spicy odor.

The mucosa of the Pigeon's gizzard—as is well-known to be the case in other birds—is sometimes stained by the soluble pigments in the ingested food. It is probable that, in the Nutmeg Pigeon, the yellowish discoloration around the bases of the cones may be due to this cause. The remaining mucous and submucous membranes were of the usual color.

As will be seen by the figure, the bisected gigerium measures 6.3 cm. by 1.5 cm. The thickness of the walls varies from 2.5 mm. to 4 mm. The arrangement of the cones on their muscular base differs somewhat from that found by Garrod in *C. latrans.*

Although there are, as in that species, 23 well-defined conical processes yet they are not placed, so far as the present writer's investigations show, in the regular order described by him. As shown in the accompanying illustration, only nine cones answer to the author's record of regular disposition in combined lines and columns of three. The remaining fourteen are in *pacifica* irregularly scattered—two lines each of two's and three's and two singles —covering pretty thoroughly between them the whole inner surface of the stomach. This disposition of the gizzard cones was found to be practically constant in all the Nutmeg Pigeons examined by the writer. The height of the cones and the diameter of their bases correspond closely to the figures furnished by Garrod except that in *pacifica* the basal structures appear to be of the same diameter (about 5 mm.) in all, regardless of their height, and not as great as that recorded in *latrans;* yet this difference may be chiefly due to methods of measurement. While the mucous membrane presented a smooth and shiny surface throughout it was plicated between the rows of cones, as one might expect of the lining of an organ subject to frequent distention by the forcible entry of large bodies into its interior. The artist has not, in the illustration, succeeded in portraying very successfully the elevation of the pointed cones nor the entrance of the oesophagus and duodenum, but as the main purpose of the drawing is to show the disposition of the cones and the relative size of the whole organ, this defect is not of much practical importance.

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