appear to be mainly due to the difference in the method of preservation.

Hab. Apoh River, base of Mount Batu Song, Baram district, East Sarawak.

Type collected September 1891.

The typical skin of this species was obtained by Mr. A. H. Everett, and was recognized both by him and Mr. Charles Hose (who also got a specimen at the same time and place) as a different species to any previously known to them ; and this opinion is quite confirmed by an examination of the Museum collection of *Tupaiæ*. There is, however, another example of it in the Museum, obtained by the Marquis G. Doria in Sarawak in 1867, and generously presented by him in 1888. This specimen I had not previously closely examined, but had supposed it to be an old individual of *T. minor* ; it proves on comparison, however, to be quite similar to the example collected by Mr. Everett.

Although without any conspicuous or specially characteristic colours or markings, *T. gracilis* is readily distinguishable both by its size (in which it is just intermediate between two groups of species) and by its coloration, the only species resembling it at all in this respect being the much smaller and sharper-nosed *T. minor* and the equally larger *T. Belangeri* of Burma and the Malay Peninsula.

XV.—*The Coxal Glands of* Scorpio. By Henry M. Bernard, M.A. Cantab. (from the Huxley Research Laboratory).

[Plate II.]

While working at the comparative morphology of the Galeodidæ, I have found it necessary to make a careful examination of the coxal glands of *Scorpio*, for purposes of comparison. Although these glands, through the researches of Lankester * and Sturany †, are already fairly well known, some points were left uncertain and vague—*e. g.*, the nature of the "medullary substance," and the question whether in adults the glands opened to the exterior. This paper embodies the definite results which I have obtained on these two interesting points.

While reserving full details of the coxal glands of *Galeodes*

* "On the Skeleto-trophic Tissues and Coxal Glands of *Limulus*, *Scorpio*, and *Mygale*," Quart. Journ. Micr. Sci. xxiv., 1884.

† "Die Coxaldrüsen der Arachnoideen," Arb. Zool. Inst. Wien, t. ix. Heft 2, 1891.

for my larger publication, it is necessary briefly to describe them here, as their arrangement throws important light on the morphology of the coxal gland in *Scorpio*. A long coiled tube opens just behind the first pair of legs; it runs backwards among the muscles and nerves, free of connective tissue, then, bending forward again, ends near its external opening. The proximal end of this long duct is occasionally found expanded into a spongy mass of branching and anastomosing tubules, which join with the similar mass of tubules from the coxal gland of the other side to form a barrier across the cephalothorax. Through this spongy mass the blood, flowing backwards freely through the body, must filter. It is important to bear in mind that these tubules are simply a development of the ends of the ducts, and the whole may be dissected out free from the body without any entanglement of connective tissue or blood-vessels, which latter do not exist in *Galeodes*.

I am inclined to think that the histology of this gland is not so simple as it appears at first sight, and that Macleod's description* of it, though in the main correct, requires revision. I am not, therefore, as yet in a position to make any histological comparisons between the coxal gland of *Galeodes* and that of *Scorpio*.

The gland opens in *Scorpio*, not on the first leg, as in *Galeodes*, but in exactly the spot where I have recently shown † that the coxal gland of the Chernetidæ opens, viz. on the posterior face of the coxa of the third leg. In *Scorpio* this posterior face of the coxa of the third leg is fused with the anterior face of the coxa of the fourth leg. But this fusion is so far incomplete as to form a channel close up against the body; this channel runs forward from the external opening of the gland, so that the excretory matters find their way to the exterior between the tips of the coxæ of the third and fourth pairs of legs close to the sternal plate. In serial sections both the duct of the coxal gland, on its way to the chitinous channel thus formed by the fused coxæ, and the chitinous channel itself are very easy to find, and the fact that they have been missed by former investigators ‡ can only be explained by the frequent tearing of the sections by fragments of hard chitin.

Plate II. fig. 1 shows the chitinous channel in section, while figs. 2 and 3 show the connexion of the duct of the coxal gland with this channel.

The duct of the gland is much coiled and forms a compact

* Bull. Ac. Bruxelles (3) t. viii., 1884.
† Journ. Linn. Soc., Zoology (in press).
‡ Quart. Journ. Micr. Sci. xxiv. p. 154.

mass bound together by connective tissue. The walls of the duct are bulged out to form what look like short branches, but which are in reality only pocket-like outpushings. A large nucleus lies in each pocket.

The cells of the duct are no longer demonstrable as simple cells; their outermost portions are arranged in strands of staining protoplasm and clear matter. Lankester has suggested that these clear striæ might be tubes; but I think it more probable that they are inflowing streams of the excretory matter. This excretory matter, after passing through the outer portions of the cells, seems to be absorbed by the nuclei, which swell enormously and bulge out the wall of the duct as above described. In this swollen state they no longer take stain, but are large clear vesicles which are detached into the lumen of the tube, where they finally break down. Besides these enormous nuclei (21 μ in long diameter), others of all sizes are found, some comparatively small (12 μ), with deeply-staining chromosomes. Although I have found no traces of dividing nuclei—dividing *i. e.* in order to replace those which are cast off—Lankester has a figure * of the coxal gland of *Buthus cyaneus* in which the nuclei are obviously dividing. Between the nuclei and the lumen of the tube there is a very thin layer of staining and apparently undifferentiated protoplasm.

While in *Scorpio* the nuclei appear, as above described, to absorb the excretory matter and to be cast off, in *Galeodes* this matter is apparently collected in vacuoles of the cytoplasm, which are then detached and fill the lumen of the duct with clear round vesicles. The detachment of the nuclei in *Scorpio* has been mentioned by Lankester and Sturany; but both seem doubtful whether this may not be due to the preparation of the sections. Fig. 2, however, shows a portion of the duct in which there are more detached nuclei in the lumen of the duct than could have been derived from the wall, where, indeed, the nuclei are still found *in situ*. Further, the different character of the nuclei (the solid staining and the large clear vesicular nuclei) seems to have escaped observation. The latter alone are found free in the lumen of the duct. This remarkable function of the nuclei, as to the correctness of which I think there can be little doubt, deserves further investigation.

This highly differentiated duct terminates, as is sometimes the case in *Galeodes*, in a sponge-like system of branched tubules. This mass of tubules does not, however, develop freely among the tissues of the body as in *Galeodes*, but is gathered together into a compact mass, round which the main

* Quart. Journ. Micr. Sci. xxiv. pl. xii. fig. 5.

duct above described coils. These tubules are bathed in a blood-stream, which is brought by a special vessel which arises from that accompanying the nerve running into the third leg. The blood is conducted by this vessel between the anterior layer of the coil of the coxal gland, and is then discharged freely among these end-tubules. The histology of these tubules differs considerably from that of the main duct. The epithelium lining the tubules in *Scorpio* is apparently discontinuous, the cells, containing large nuclei, being irregularly scattered upon the membranous wall of the tubule (figs. 4 and 5). This mass of tubules with the blood-spaces between them has been called by Lankester the "medullary substance." This name, while it applies perhaps to the state of the end-tubules figured by him, which must represent that of a very young specimen, is totally inapplicable to the adult condition. That this part of the gland happens to be medullary at all is simply due to the coiling of the main duct around its proximal branched portion. In the Chernetidæ we also have the proximal end of the gland surrounded by the coils of the duct; but there are no branching tubules such as we find in *Galeodes* and *Scorpio*.

No one can examine these end-tubules of the coxal gland of *Scorpio* without being reminded of the end-saccules to the antennal and shell-glands of the Crustacea. Sturany suspected that these tubules represented a typical end-saccule, but was unable to prove it. Perhaps I have been more fortunate in my sections; working from before backwards, it is easy to find in the anterior sections the blood-spaces in connexion with the blood-vessel above described. The actual opening of the blood-vessel into the blood-spaces is much disguised by a peculiar group of cells (Pl. II. fig. 4, *c*), between which the blood seems to flow. In these sections the blood-spaces are more conspicuous than are the tubules. In the posterior sections the connexion between the main duct and the tubules is also easy to find (fig. 5).

The transition between the scattered epithelium of the end-saccule and the specialized striated epithelium of the main duct I have endeavoured to show in fig. 5.

The presence of typical end-saccules at the proximal ends of the coxal glands of *Galeodes* and *Scorpio* has an important bearing on the morphology of the antennal and shell-glands of the Crustacea. In the first place, it is difficult to doubt that these are all homologous structures; the extraordinary histological likeness between the main ducts and their common development of end-saccules seems to me to render the homology almost certain. The great importance of this homology, however, lies in the fact that the end-saccule in

the Crustacean gland would then be, what it clearly is in *Galeodes*, a development of the proximal end of an originally simple tubule, and not, as is often suggested, a modified portion of a primitive cœlom.

The establishment of this point would be one more argument in favour of my view that the antennal and shell-glands of the Crustacea are probably derivations of acicular or setiparous glands*. It is interesting to note that a similar suggestion had already been made by Eisig† with regard to the origin of the coxal glands of the Arachnids.

In both cases (*i. e.* in Crustacea and Arachnida) we should then have setiparous glands gradually specialized for excretory purposes as the primitive nephridia became specialized into genital ducts. The extreme plasticity of the setiparous glands is well known—slime-glands, spinning-glands, and poison-glands being generally deduced from them; further, tracheal invaginations and salivary glands may also with great probability be traced back to them. That some of them should have become specialized for excretion is not improbable.

Without enlarging any further on this suggested derivation of the antennal and shell-glands of the Crustacea and the coxal glands of the Arachnida from setiparous sacs, I should like to point out a remarkable physiological connexion which appears to exist between the different kinds of Arachnidan glands. *Galeodes* has no spinning- or poison-glands, but highly developed coxal glands and Malpighian vessels. *Scorpio* has well-developed stinging-glands, which, however, are but occasionally employed, and well-developed coxal glands and Malpighian vessels. The Chernetidæ have very large true spinning-glands and modified spinning- (cement-) glands, which are periodically developed. They have, further, coxal glands, but no Malpighian vessels. In these animals we have to bear in mind that the spinning- and cement-glands are not always functional, so that some purely excretory apparatus for the direct removal of waste products is required during those times when these excretory matters are not being utilized for the formation of silk or cement.

In the Araneidæ we have, as a rule, a perennial flow of silk and a consequent degeneration of the purely excretory glands. The coxal glands have, as a rule, degenerated, while the Malpighian tubules no longer come in contact with the blood-stream, but ramify through the peritoneal cells which bind the numerous diverticula of the mid-gut into a solid mass,

* 'The Apodidæ' (Macmillan, 1892).

† Eisig, 'Die Capitelliden des Golfes von Neapel' (1887).

often erroneously called the "liver." The Malpighian tubules have here, as it appears to me, become specialized for the removal of fæcal matter from the tips of the diverticula*. In this case the waste products appear to be entirely used up in the formation of silk.

We find, then, a distinct physiological connexion between the purely excretory glands and the silk-glands; when the latter are well developed, the former tend to atrophy or to become specialized for other functions, and, on the other hand, when there are no glands for using up the waste products the purely excretory glands are well developed. This physiological relationship need not necessarily imply any homology between the spinning- and poison-glands, on the one hand, and the excretory glands (coxal glands and Malpighian vessels) on the other. At the same time the common derivation of all these glands from setiparous sacs would render such connexion very natural.

EXPLANATION OF PLATE II.

Fig. 1. A transverse section of *Euscorpio italicus*, passing through the tip of the coxa of the fourth leg, c_4. c_3, coxa of third leg, the posterior face of which is fused with the anterior face of c_4, leaving, however, an open channel, *ch*; *en*, endosclerite; *n*, nerve to the third leg (the accompanying blood-vessel gives off a branch, *b*, to the coxal gland); *sp*, sternal plate.

Fig. 2. A few sections further back, showing the part of the duct (*d*) leaving the chitinous channel (*ch*), and the blood-vessel (*b*) running backwards. The coil of the coxal gland is also cut through tangentially; nuclei in various stages of vesiculation are found, the largest and most vesicular being detached.

Fig. 3. A portion of the cuticle of *Palamnæus Thorellii*, Pocock, macerated in caustic potash, showing the posterior face of the coxa of the third leg seen from within. *ma*, chitinous attachments for muscles; *ch*, the channel between c_3 and c_4; *d*, chitinous intima close to the aperture of the duct; *sp*, portion of the sternal plate.

Fig. 4. Anterior section through the end-saccule (the so-called "medullary substance"). The clear portions are the blood-passages, the dotted parts are the tubules of the end-saccule. The opening of the blood-vessel is marked by a curious aggregation of cells (*c*) (? Sturany's "Blutzellen") between which the blood flows.

Fig. 5. Posterior section through the end-saccule, showing that the latter is but an expansion of the coiled duct. Between the scattered epithelium of the end-saccule and the highly specialized epithelium of the coiled duct occurs a short band of epithelium apparently quite undifferentiated.

Fig. 6. Diagram of the gland, showing the special blood-vessel discharging its contents among the tubules of the end-saccule. Lettering as above.

---

* "Notes on some of the Digestive Processes in Arachnids," Journ. R. Micr. Soc. (in press).