FORT HARE PAPERS

VOL. 1 FEBRUARY, 1951 No. 5

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PRICE 2/6

PUBLISHED BY
THE FORT HARE UNIVERSITY PRESS

The publication of this copy has been aided by a grant from The Bantu Welfare Trust.

SOME MORE EGG-SHELL ENGRAVINGS

BY

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THE PARASITES OF ARDEA MELANOCEPHALA FROM THE EASTERN PROVINCE

BY

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A Thesis submitted in part fulfilment for the degree of Master of Science of the University of South Africa

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THE FORT HARE UNIVERSITY PRESS

CONTENTS

LIST OF ABBREVIATIONS

CIR.S.	—	Cirrus sac
D.E.	—	Ductes ejaculatorius
MT.	—	Metraterm
OV. DUC.	—	Oviduct
OV.	—	Ovary
O.T.	—	Ootype
L.C.	—	Laurer's canal
UT.	—	Uterus
PN.	—	Penis
V.S.	—	Vesicula seminalis
Y.R.	—	Yolk reservoir
TA.	—	Tail
INT.	—	Intestine
CUT.B.	—	Cuticular bell
OV. JEC.	—	Ovijector
VAG.	—	Vagina
E. V.	—	Excretory vesicle
E. T.	—	Excretory tube

PREFACE

The present work was carried out in preparation for a dissertation for the degree of Master of Science (in Zoology), in the University of South Africa.

The author started this research with two aims in view. Firstly the author wished to meet a demand in a field of research which South African biologists seem to have neglected. It is true some parasitic research of a very high standard is being carried out in the Government Veterinary Laboratories at Onderstepoort but that work is mainly concerned with the parasitic infestation of domestic animals. Much work has however been done on South African birds and their ecology, but except for isolated parasites found by workers here and there, the list of Avian parasites as compiled by workers like Fuhrmann, et al, is still far from complete.

The second aim in carrying out this investigation was to discover the probable parasite chain linkages which might exist through the host Ardea melanocephala. The latter although protected by law in these provinces has a bad reputation with farmers as an enemy to poultry and game birds. This work indicates that this reputation is not deserved.

The first chapter deals with the analysis of the diet, which it was found consists chiefly of Arthropoda especially Acridiidae and Gryllids. The second chapter discusses the average parasitic incidence per type and tabulates for the sake of comparison and completeness parasite types which have already been described in other Ardeidan hosts throughout the world. The remaining chapters deal specifically with the individual parasites as they occurred in and on the host.

ACKNOWLEDGEMENTS

The sincere thanks of the author goes to the South African Institute of Industrial and Scientific Research who provided the funds which made this work possible.

I am further greatly in debted to the following :

Dr. R. J. Ortlepp and Dr. G. Theiler who gave invaluable aid to the author with the loan of literature.

Mr. Taylor, Government Entomologist at Fort Beaufort who kindly lent the author an unpublished copy of his findings of the diet of A. melanocephala.

Professor A. J. D. Meiring, Head of the Department of Zoology, Fort Hare, for the advice, and encouragement to the author at all stages of this work.

CHAPTER I.

DIET AND HABITS

The material which forms the theme of this dissertation was collected from specimens of Ardea melanocephala (synonym—Ardea atricellis), shot on farms surrounding Fort Hare, and on the banks of the Tyumie River in the Victoria East District. This area is characterised by fairly dense Mimosa thickets with scattered marshland whilst the river bank has many tall trees on which the Herons sometimes rest, but their main roosting places are on tall trees on the Lovedale Grounds about half-a-mile from the river. Along the river bank are fairly extensive cultivated lands and this is where most of the specimens were shot. The herons showed a preference for fields of Medicago where an intensive insect fauna was observed.

Ardea melanocephala occurs throughout Africa, Madagascar and according to Starke and Sclater[1] is a straggler into Southern Europe. During the breeding seasons it is found sometimes associating in nests with Bulbucus ibis—the Cattle Egret, the distribution of which co-incides with that of Ardea melanocephala, except that the Egrets are also found in South Western Asia. When such heronries occur, the nests of Ardea melanocephala are generally placed on the higher branches while those of Egrets are found below them. These heronries are either built on high desolate trees away from domestic surroundings or posted on the tops of high trees growing amongst houses. To capture its prey the strong bill is poised for a time and then shot forwards like a javelin. The specimens examined were either shot from roosts in Egret-heron colonies, or from small groups of two or three, such groups generally including a stray grey Heron—Ardea cinerea cinerea.

One heronry of Egrets and Herons was specially observed on a pine tree approximately 80 feet high. Below this tree could be found several pellets or castings consisting of apparently undigested portions of food regurgitated by the roosting birds. These were comprised mostly of legs of grasshoppers and beetles, skeletal remains of Vertebrates, and dense wads of Mammalian fur.

For a qualitative study of the diet these pellets or castings prove to be very useful as in most cases the regurgitated animals are not too severely mutilated for examination. This method, however, only works with satisfaction in the case of an exclusively Heron colony like that examined by Mr. Taylor at Fort Beaufort. (His observations are described in an unpublished paper prepared for the journal " Ostrich " of the Ornithological Society of South Africa, and which he kindly loaned me).

In order to get more or less accurate qualitative and quantitative aspects of the diet, immediately after the specimens of Ardea melanocephala were shot the contents of the gizzard were carefully examined. In order to cover all the seasons, the birds were shot over a period of sixteen consecutive months, at the rate of one specimen every month.

Of the total number of specimens examined only nine have been recorded, the remaining seven having an exclusively insect diet and in very low numbers. The following analyses the diet thus :—

SPECIMEN	NATURE OF FOOD	NUMBER OF TYPES	% TYPES
A.	Acridiidae	75	
	Coleoptera	23	
	Gryllidae	3	100%
	Sphingid larvae	18 (43 gms)	Insect
	Other larvae	14 (8 ,,)	
B.	Acridiidae	119)	
	Coleoptera	47)	99.4% Insect
	Gryllidae	3)	
	Arachnid (Solpuga)	1	.6% Arachnid
C.	Otomys irroratus	1	7% Mammalian
	Crangon vulgaris	1	7% Crustacean
	Microchaetes (sp)	11	84% Annelid

SPECIMEN	NATURE OF FOOD	NUMBER OF TYPES	% TYPES
D.	Rana (sp.)	6	43% Amphibian
	Crangon vulgaris	3	22% Crustacean
	Acridiidae	1)	
	Coleoptera	2)	35% Insect
	Larval types	2)	
E.	Acridiidae	9	90% Insect
	Acontias plumbeus gracilicauda	1	10% Reptilian
F.	Acridiidae	31)	
	Coleoptera	1)	100% Insect
	Gryllidae	20)	
G.	Acridiidae	8)	
	Gryllidae	55)	99% Insect
	Larval types	4)	
	Otomys irroratus	1	1% Mammalian
H.	Otomys irroratus	1	100% Mammalian
I.	Acridiidae	31)	
	Gryllidae	1)	100% Insect

The remainder of the specimens examined varied in the contents of the gizzard from empty to a few insects.

From this table it is evident that the diet of Ardea melanocephala comprises a wide range of animal types both vertebrate and invertebrate. Collectively the diet of these 9 specimens contained :—458 insects and insect larvae, 4 crustaceans, 1 arachnid, 11 annelids, 6 amphibians, 1 reptile and 3 mammals.

By far the preponderating article of diet is insects, the other groups comprising a more or less secondary relish.

This observation agrees fairly closely with the analysis of the diet of Ardea melanocephala, carried out by Mr. Taylor from the regurgitated pellets, but differs from it as regards the high percentage of Mammalian and Reptilian types viz., 61% and 59% respectively.

The list of Vertebrates found by him under an exclusively Heron colony he examined during a course of six months comprises :—

MAMMALS :
- Cryptomys hottentotus .. .. : 8 specimens.
- Otomys irroratus .. .. : 1 specimen.
- Mouse (sp.) .. .. : 1 ,,

AVES :
- Nestling Sylviidae .. .. : 1 specimen.

REPTILES :
- Mabuya capensis .. .. : 13 specimens.
- Agama species .. .. : 1 specimen.
- Acontias meleagris .. .. : 1 ,,
- Acontias plumbeus gracilicauda .. .. .. : 1 ,,

AMPHIBIANS :
- Rana delalandi .. .. : 2 specimens.

In the present work the list of Vertebrates stands out thus :—

MAMMALS :
- Otomys irroratus .. .. : 3 specimens.

REPTILES :
- Acontias plumbeus gracilicauda .. .. .. : 1 specimen.

AMPHIBIANS :
- Rana species .. .. : 6 specimens.

No nestlings or small birds were found, and although under the heronry which was under examination one, now and again, found dead nestlings of Egrets and Herons, those belonging to other types were never found.

The analysis by Mr. Taylor, therefore, gives a very high percentage of Vertebrate types, a difference which may be accounted for by the differences in the topographical lie of the two areas, the Fort Beaufort area being more open with less of the Mimosa thickets characteristic of the Alice environs, and perhaps also due to the fact that the specimens worked upon in Alice were mainly from cultivated fields instead of wild natural plains, where lizards and rats are usually found, although some of these specimens were shot when coming to their roosts in the evening, but it is of course impossible to say where they came from.

The idea, therefore, that Ardea melanocephala feeds chiefly on fish (Starke and Sclater[1]) is not strictly correct. From the wide range of animal types which include aquatic types like Crabs, it is quite probable that where fish are available Ardea melanocephala would take them, as shown for instance by the infection experiment carried out by Ortlepp[2] in the feeding of parasitized Gnathonemus macrolepidotus to a young Black-headed Heron. Nor apparently do Frogs comprise one of the chief articles of diet as suggested by Roberts[3]. For of all the specimens examined, only in one were frogs met with, and the number obtained by Mr. Taylor seems to support this contention.

Due to the abundance of wet situations in this locality, frogs are on the whole fairly common, and one would have expected to find more of them if they were a chief article of diet.

Ardea melanocephala is, therefore, chiefly an insect-feeder, predating heavily on the Orthoptera and Coleoptera. The Vertebrate types thus fall in its diet sheet, in proportion to the amount available in its particular range of predation.

From an appraisal of these facts it is evident that Ardea melanocephala is of considerable economic importance to Agriculture, because of the high toll it takes of insects injurious to horticultural products. Also if the incidence of a rodent population is fairly high within the predation range of Ardea melanocephala, then it must be assumed that these Herons do considerable good as allies in the biological control of rodent-borne diseases.

As far as its negative effects in the predation on earthworms, it can be observed that this is negligible and the table clearly indicates that these occurred in only one out of sixteen Herons examined. As regards the Reptilian fauna, perhaps Mr. Taylor's observation is a correct surmise when he writes—"The bird probably does as much harm as good, for these creatures occupy a more or less neutral position in the scheme of things."

CHAPTER II.

INCIDENCE OF PARASITES AND A CATALOGUE OF KNOWN PARASITES OF CERTAIN ARDEIDAE

In examining the general incidence of parasites on the hosts, it was found that, of the Ectoparasites, the general prevalency of the Mallophaga was almost 100% while of the Endo-forms that of the Trematodes with 65% was the highest. The Nematodes show the next degree of general prevalency, being absent in six specimens out of sixteen Herons examined. Larval Argasids were recorded only from two hosts, but when the nests from a heronry of Bulbucus ibis and Ardea melanocephala were examined, they showed a high incidence of adult forms. As the nests examined were not from an exclusively Heron colony, the collection of either the larval forms from the hosts or the occurrence of tampans in the nests, had to be controlled in order to establish that the parasites were not merely stragglers from the Egrets but were parasitic on Ardea melanocephala. Such a control was found in a verbal report from Mr. Taylor, Government Entomologist, Fort Beaufort, who had found the same Argasids from a tree which hitherto had been the abode of an exclusively Heron colony (A. melanocephala).

The following classes of parasites are represented :—

A. *ECTOPARASITES.*

(i) Mallophaga (Two families—Menoponidae and Philopteridae).

(ii) Arachnida (One family—Argasidae).

B. *ENDO-PARASITES.*

(i) Trematoda (One family—Echinostomatidae).

(ii) Nematoda (Two families—Acuariidae and Thelaziidae).

The total absence of Cestodes is a remarkable fact as it would be expected that a bird with such a wide range of feeding types, especially Arthropodan, would serve as a host for some of those Cestodes whose phoresis depends on Arthropodan vectors.

Of the two types of Mallophaga collected the Philopterid, Ardeicola ardeae, shows a more genera prevalency having been recorded from all specimens examined. The Menoponid Ciconiphilus decimfasciatus exhibited a low frequency occurring on only six hosts. In its distribution over the body of the host, Ciconiphilus decimfasciatus was generally confined to the under-wing coverts and at the basal portions of the upper- and under-tail coverts. On the other hand, Ardeicola ardeae had a wider distribution over the host's body with no regional concentration—a fact perhaps due to the magnitude of the numbers of this species.

The relative frequencies of the two types of Mallophaga show as follows for six specimens :—

ARDEICOLA ARDEAE		CICONIPHILUS DECIMFASCIATUS	
	32		7
	45		2
	12		2
	78		15
	18		3
	70		36
TOTAL	255	TOTAL	65

The Trematodes varied much in their density per host, the number collected per specimen ranging from a single individual to fifty odd. All these were confined to the posterior half of the duodenum and the proximal portion of the ileum. No pathological condition was observed and it would appear that these parasites lie free in the lumen of the gut. In one specimen which had a Trematode yield of fifty seven, the gut was apparently blocked, a condition which apparently would ultimately lead to stenosis.

The Nematodes comprise two species, Synhimatus invaginata found in the tunic of the gizzard, and Desmidocercella kwalimanzi (nov. sp.) found in the air-sacs, lungs and serous cavities of the Heron. The general incidence varied slightly, S. invaginata occurring in 43% of the hosts while D. kwalimanzi had a mean prevalency of 34%.

Several Nematode, Cestode and Trematode types have been described from several members of the family Ardeidae.

Some genera show an appreciably wide intrafamilial distribution. Of the Nematoda the genera Contracaecum (Raillet and Henry 1912) and Porrocaecum (Raillet and Henry 1912) occur in several Ardeidan host types, and Cram[4] records the description of a male of Porrocaecum serpentulus from Ardea melanocephala found by Mönnig in the Transvaal. The Trematode genus Clinostomum also has a wide range of Heron host-types. In connection with Clinostomes and their occurrence on Ardea melanocephala mention might be made of a new species Clinostomum v.d. horsti (Ortlepp) described from Ardea melanocephala. Ortlepp[2] fed to a young Heron (A. melanocephala) a few specimens of Gnathonemus macrolepidotus heavily parasitized by Clinostome meta-cercariae. The adults of these occurred a few days later on the mucus membrane of the mouth and glottis. It might be observed that, whether Clinostomum v.d. horsti is a normal parasite of Ardea melanocephala or not, requires more conclusive evidence, as the present host-parasite relationship was artificially induced. According to

Ortlepp[2] Yamaguti (1933) also carried out similar infection experiments on a Heron using Clinostomum complanatum (Rudolphi).

As regards the Cestode parasites of Ardeidae several genera have been recorded from different parts of the world, and it is a striking fact that none of these Platodes have as yet been recorded from Ardea melanocephala.

The following is a world-representative catalogue of the known parasites of some of the members of the family Ardeidae as recorded from Cram[4], Bedford[5], Viana[7] and Fuhrmann[8] :—

MALLOPHAGA

HOST	PARASITE
Ardea cinerea	Ardeicolla ardeae (Linne.) Ciconiphilus decimfasciatus (Bois. & Lac.) Lynchia ardeae (Macq.)
Ardea comata	Ardeiphilus trochioxus (Nitzsch). Colpocephalum zonatum (Rudow).
Ardea egretta	Ciconiphilus decimfasciatus (Bois. & Lac.)
Ardea garzetta	ditto. Lynchia ardeae (Macq.)
Ardea grayi	Ciconiphilus decimfasciatus (Bois. & Lac.)
Ardea herodias herodias	ditto.
Ardea melanocephala	ditto.
Botaurus lentiginossus	ditto.
Botaurus stellaris	Ardeiphilus trochioxus (Nitzsch). Ardeicolla stellaris (Denny). Philopterus ovatus (Giebel). Pterallophus stellaris (Buchkholz).
Bulbucus ibis	Lynchia ardeae (Macq.)
Casmerodius albus	Ciconiphilus decimfasciatus (Bois. & Lac.) Colpocephalum oreas (Kellogg). Neophilopterus episcopi (Kellogg).
Demi-egretta sacra ringeri	Ciconiphilus decimfasciatus (Bois. & Lac.)
Ixobrychus minutus	Ciconiphilus decimfasciatus (Bois. & Lac.) Philopterus sulcatus (Piaget).
Nycticorax nycticorax	Ciconiphilus decimfasciatus (Bois. & Lac.)
Nycticorax nycticorax maevius	ditto.
Phoyx purpurea	ditto.
Pyrrherodia purpurea	Ardeiphilus trochioxus (Nitzsch). Ardeicola leucoprocta Nitzsch).

TREMATODA

HOST	PARASITE
Ardea cocoi	Clinostomum detruncatum (Braunn). Clinostomum marginatum (Rud.) Clinostomum sorbens (Braunn). Distomum trifolium (Braunn). Episthmium proximum (Trav.) Opisthorchis interreptus (Braunn).

TREMATODA

HOST	PARASITE
Ardea cinerea	Ascocotyle minuta (Looss).
	Echinostoma bursicola (Creplin).
	Echinochasmus beleocephalus (Lin.)
	Echinochasmus oligacanthus (Lhe.)
Ardea melanocephala	Clinostomum v.d. horsti (Ortlepp)
Ardetta minuta	Echinostoma spathulatum (Rud.)
Agamia agami	Diplostomum grande (Dies.)
Botaurus minor	Echinochasmus aspersum (Wright)
Botaurus stellaris	Chaunocephalus ferox (Rud.)
	Echinochasmus botauri
	Pegosomum spiniferum (Ratz.)
Butorides virescens	Opisthorchis interreptus (Braunn.)
Butorides striata	Ascocotyle angrense (Trav.)
	Opisthorchis interreptus (Braunn.)
Bulbucus ibis	Nephrostomum ramosum (Sons.)
Cancroma cohlearis	Clinostomum marginatum (Rud.)
Florida caerulea	Clinestomum heluans (Braunn).
Garzetta garzetta	Echinostoma garzettae (McCall).
Herodias alba	Pegosomum saginatum (Ratz.)
Herodias egretta	Clinostomum detruncatum (Braunn.)
	Diplostomum grande (Dies.)
	Opisthorchis interreptus (Braunn.)
Nyctanassa violacea	Clinostomum heluans (Braunn.)
	Clinostomum marginatum (Rud.)
	Levinseniella simillina (Trav.)
	Lyperosomum sinuosum (Trav.)
	Odhneria odhneri (Trav.)
	Parorchis proctobium (Trav.)
Nycticorax nycticorax naevius	Clinostomum marginatum (Rud.)
	Episthmium proximum (Trav.)
	Opisthorchis interreptus (Braunn.)
Pilherodias pileatus	Opisthorchis interreptus (Braunn.)
Syrigma sibilatrix	Nephrostomum limai (Trav.)
	Opisthorchis interreptus (Braunn.)
Tigrisoma brasiliensis	Opisthorchis interreptus (Braunn.)

CESTODA

HOST	PARASITE
Ardea cinerea	Anomotaenia leuckarti (Fuhr.)
	Dilepis unilateralis (Rud.)
	Gryporhynchus cheilancristata (Wedl.)
	Hymenolepis micro-cephala (Rud.)
Ardea comata	Dilepis unilateralis (Rud.)
	Gryporhynchus pusillus (Nord.)
Ardeolla ralloides	Dilepis macrosphincter (Fuhr.)
Botaurus stellaris	Cyclustera fuhrmanni (Clerc.)
	Gryporhynchus cheilancristata (Wedl.)

HOST	PARASITE
Butorides atricapilla	Hymenolepis ardeae (Fuhr.)
Butorides striata	ditto.
Butorides virescens	Dilepis unilateralis (Rud.)
	Hymenolepis ardeae (Fuhr.)
	Tetracisdicotyle macroscolecina (Fuhr.)
Garzetta garzetta	Dendrouterina herodiae (Fuhr.)
	Dilepis unilateralis (Rud.)
	Raillietina circumcincta (Krabbe.)
Herodias egretta	Dilepis unilateralis (Rud.)
Herodias timoriensis	Anomotaenia asymetrica (John.)
	Bancroftiella glandularis (Fuhr.)
Nycticorax caledonicus	Bancroftiella ardeae (John.)
Nycticorax nycticorax	Gryporhynchus pusillus (Nord.)
	Hymenolepis micro-cephala (Rud.)
	Tetrabothrium porrigens (Molin.)
	Valipora mutabiles (Linton.)
Notophoyx novae-hollandiae	Bancroftiella glandularis (Fuhr.)
Pilherodias pileatus	Dendro-uterina nycticoracis (Olsen.)
	Dendro-uterina lintoni (Olsen).
Phoyx purpurea	Anomotaenia papilla (Fuhr.)
	Dilepis macro-sphincter (Fuhr.)
	Gryporhynchus pusillus (Nord.)
	Hymenolepis micro-cephala (Rud.)
	Lateriporus mahadiaensis (Joyeux).

NEMATODA

HOST	PARASITE
Ardea agami	Porrocaecum serpentulus (Rud.)
Ardea caerulea	Contracaecum anderson (Verras).
	Porrocaecum serpentulus (Rud.)
Ardea cinerea	Contracaecum micro-cephalum (Rud.)
	Desmidocerca aerophila (Skrjabin).
	Desmidocercella numidica (Seurat).
	Porrocaecum reticulatum (Lin.)
	Porrocaecum serpentulus (Rud.)
Ardea cocoi	Eustrongylidis ignotus (Jaeger.)
	Porrocaecum reticulatum (Lin.)
Ardea comata	Contracaecum micro-cephalum (Rud.)
	Porrocaecum serpentulus (Rud.)
Ardea garzetta	Ascaridia aegyptiaca (Lin.)
	Eustrongylidis africanus (Jaeger).
Ardea grus	Ascaridia stroma (Lin.)
	Capillaria obtusiusculla (Rud.)
	Schistorophas bisuspis (Rud.)
Ardea herodias	Contracaecum micro-cephalum (Rud.)
	Echinuria ardeae (Smith Fox & White).
	Eustrongylidis ignotus (Jaeger.)
	Eustrongylidis perpapillatus (Jaeger.)

Ardea leuce	Contracaecum micro-cephalum (Rud.)
	Eustrongylidis perpapillatus (Jaeger.)
Ardea melanocephala	Porrocaecum serpentulus (Rud.)
Ardea minor	Contracaecum micro-cephalum (Rud.)
	Streptocara triaenuche (Wright).
Ardetta minuta	Synhimatus invaginata (Lin.)
Ardea nycticorax	Contracaecum micro-cephalum (Rud.)
	Contracaecum rosarium (Connal).
	Porrocaecum reticulatum (Lin.)
	Synhimatus sagittata (Rud.)
	Tetrameres gynaecophila (Molin).
Ardea pileata	Porrocaecum serpentulus (Rud.)
Ardea scapularis	Porrocaecum serpentulus (Rud.)
Ardea stellaris	Contracaecum micro-cephalum (Rud.)
	Synhimatus brevicaudata (Duj.)
Ardea violacea	Porrocaecum serpentulus (Rud.)
	Tetrameres micropenis (Trav.)
Ardeolla ibis	Habronema ficheuri (Seurat).
	Microtetrameres spiralis (Seurat).
	Sunhimatus invaginata (Lin.)
	Tetrameres coccinea (Seurat).
Bulbucus lucidus	Synhimatus invaginata (Lin.)
Butorides striatus	Porrocaecum serpentulus (Rud.)
Butorides virescens	Contracaecum micro-cephalum (Rud.)
Casmerodius alba egretta	Contracaecum micro-cephalum (Rud.)
	Eustrongylidis perpapillatus (Jaeger).

CHAPTER III.

CLASS .. .. : ———————— Insects.
ORDER .. .. : ———————— Mallophaga.
SUPER-FAMILY : ———— Amblycera, Kellogg.
FAMILY .. : ——— Menoponidae, Mjoberg.
GENUS .. .. : ——— Ciconiphilus, Bedford.
SPECIES .. : C. decimfasciatus, Bois, & Lac.

The present chapter is based on a collection of Mallophaga which occurred in comparatively small numbers as already stated in the previous chapter. Of the sixteen Herons examined, these occurred in only six hosts. In all 65 were recovered. They are generally confined to the under-wing coverts and at the basal portions of the upper- and under-tail coverts.

	FEMALE		MALE	
	LENGTH	WIDTH	LENGTH	WIDTH
HEAD .. .. .. :	.348	.585	.300	.474
PROTHORAX .. .. :	.198	.395	.142	.316
MESO-META-THORAX :	.174	.506	.142	.379
ABDOMEN .. .. :	1.343	.758	.885	.379
	2.063		1.469	

(All measurements in millimetres)

According to Bedford[6] the chief characters for segregating the genera of Menoponidae appear to be :

(i) The shape of the head.
(ii) The absence or presence of either a slit or notch on the lateral margins in front of the eyes.
(iii) The absence or presence of either a comb of minute spines or bristles of setae on the venter of the posterior femora and certain abdominal sternal plates.
(iv) The male genitalia. They usually differ but may be of the same type on various genera. They are usually the same in species belonging to the same genus and in some genera it is doubtful whether they are of specific significance.

In his work on the Menoponid genera and species, Bedford[6] pointed out that the contemporary systematisation of the family Menoponidae into new genera and species was not always based on characters of real generic significance, as for example, the presence or absence of gastric teeth, or the state of development of the oesophageal sclerite. He accordingly revised the classification of some of the species, and in this work erected the genus Ciconiphilus, in which he included two species, C. africanus, Bedford, and C. decimfasciatus—formerly included in the genus Colpocephalum, Nitzsch, by Boisduval and Lacordavei.

In this text Bedford has identified several other species belonging to the genus Colpocephalum as synonymous with C. decimfasciatus.

Of the Mallophagan genera found on the Ardeidae the present specimens agree very closely with the genera Ardeiphilus, Nitzsch, and Ciconiphilus, Bedford. They differ, however, from Ardeiphilus mainly in the absence of combs on the fourth sternite, which characterise Ardeiphilus.

The present specimens are, therefore, included in the genus Ciconiphilus for which the generic diagnosis according to Bedford[6] is as follows :—

Head : about one-third or less wider than long ; fore-head and temples rounded ; on each side of the fore-head, in front of the eyes, is a broad slit ; eyes well developed ; mandibles with a single tooth ; oesophageal sclerite and glands well developed ; antennae four-jointed the second segment with a large anterior expansion, the third constricted at the base.

Prothorax : with acute wings ; mesonotum short, separated from the metanotum by a suture, the latter with lateral margins divergent.

Legs : normal, the posterior femora with combs on the venter.

Abdomen : elongate-oval, with the apical segment rounded in both sexes ; tergites and sternites with well developed plates ; third sternite only with combs at the latero-posterior angles of the plate.

Male genitalia : with the basal plate rod-like.

As already mentioned, this genus contains two species—C. africanus and C. decimfasciatus. The present specimens do not agree with the former species mainly in the absence in C. africanus of the fasciate bristles on the posterior margin of the fourth tergite. It agrees, however, with C. decimfasciatus, Bois. and Lac. This conclusion was reached by comparison with the Onderstepoort specimens mounted by Bedford, and which I was kindly allowed to examine.

The present specimen is, therefore, identified as *C. decimfasciatus.*

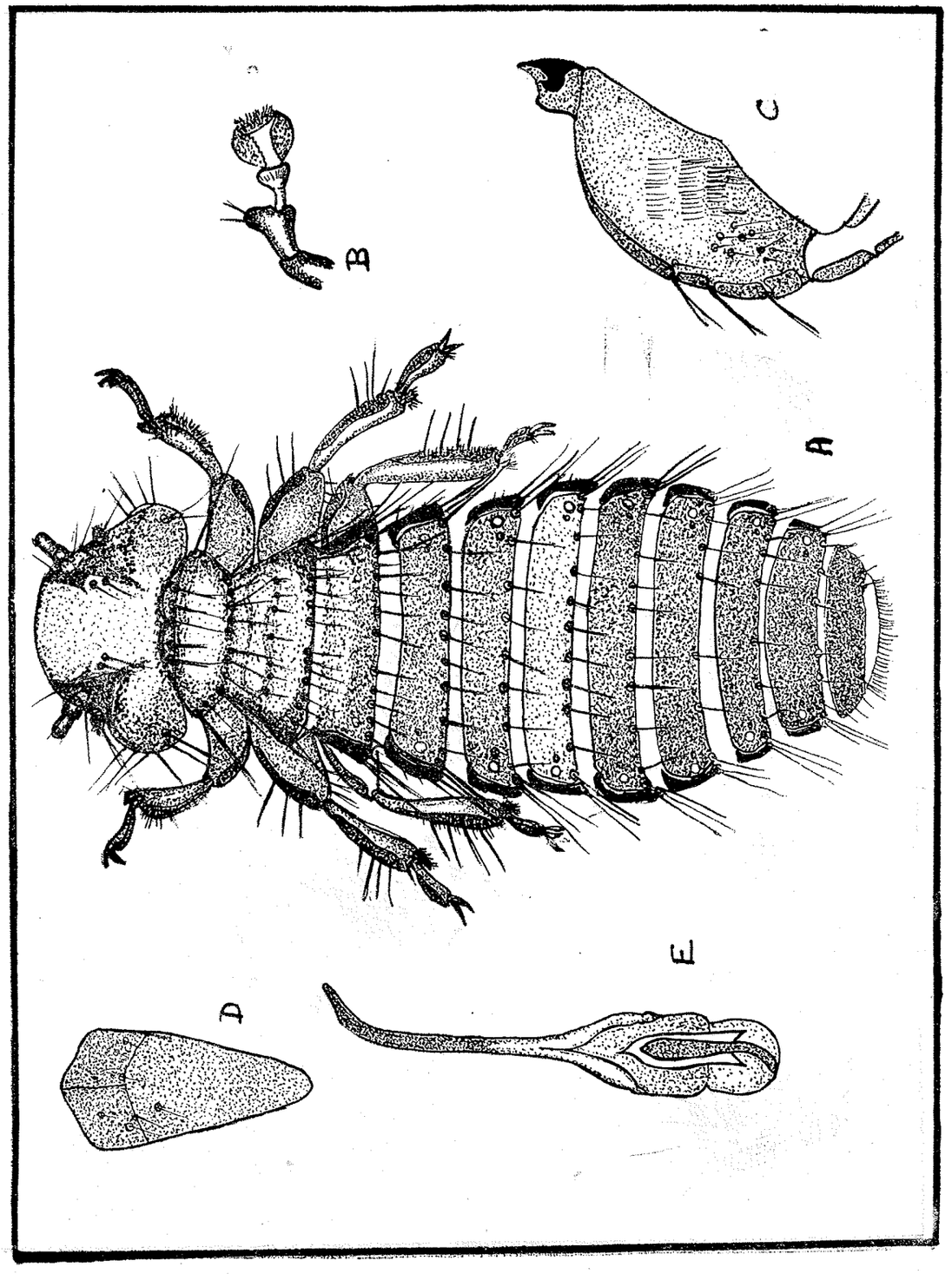
C. decimfasciatus has been collected from several Ardeiden hosts as was indicated in Chapter II, of this work.

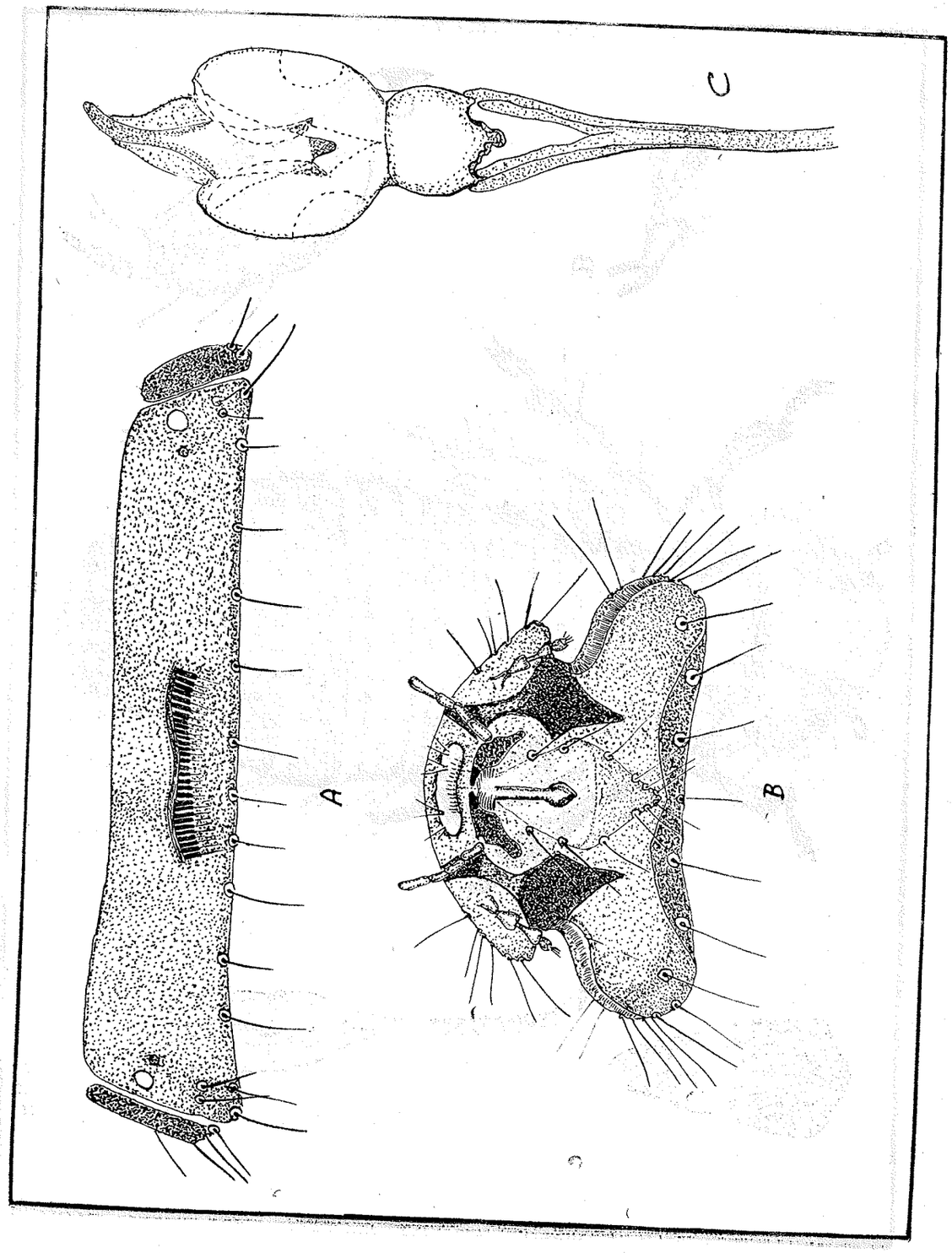
PLATE I.

A. — Adult of C. decimfasciatus from dorsum.
B. — ..... Antenna.
C. — ..... Femur of leg from venter.
D. — ..... Sternal plate.
E. — ..... Genital organ of male.

PLATE II.

A. — ..... Sternite with bristles.
B. — ..... Head of male from venter.
C. — Male genital organ with the aedaegeus protruding.





CHAPTER IV.

CLASS .. .. : ———————— Insecta.
ORDER .. .. : ———————— Mallophaga.
SUPER-FAMILY : —— Ischnocera, Kellog.
FAMILY .. : Philopteridae, Burmiester.
GENUS .. .. : ———— Ardeicola, Clay.
SPECIES .. : ——— A. ardeae, Linne.

The Mallophaga concerned in this chapter occurred in large numbers on all the Herons examined.

	FEMALE		MALE	
	LENGTH	WIDTH	LENGTH	WIDTH
HEAD .. .. .. :	.790	.490	.710	.442
PROTHORAX .. .. :	.269	.348	.237	.269
MESO-META-THORAX :	.316	.442	.285	.316
ABDOMEN .. .. :	1.959	.506	1.644	.348
	3.334		2.876	

(All measurements in millimetres).

These specimens belong to the genus Ardeicola, Clay, 1935, for which the diagnosis is as follows :—

Species elongated and of medium size (2.5—5 mms.).

Head : long and narrow, clypeus rounded in front ; clypeal signature characteristic, being practically divided into two by a suture, and having on the upper half numerous crescentic papillae or ridges, varying as to length and curvature in different species ; antennal bands turned in towards each other at the clypeal suture ; internal bands run posteriorly across the suture and pass outwards forming a goblet-shaped clear space in which lies the oral fossa ; antennae five-jointed, normal in the female, in the male first joint is enlarged and the third joint has a lateral protuberance, generally small ; pharyngeal sclerite and glands well developed.

Prothorax : small with sides very slightly divergent distally ; pterothorax longer and slightly wider than the prothorax, bearing on each side of the posterior margin four or five pustulated hairs closely grouped in a clear oval space.

Abdomen : elongated ; in female, tergal plates on segment I—VII seperated in the middle-line. In the male a varying number of the posterior segments have complete transverse plates. Spiracles present on segments II-VII. Genitalia characteristic.

This diagnosis is after Clay[10].

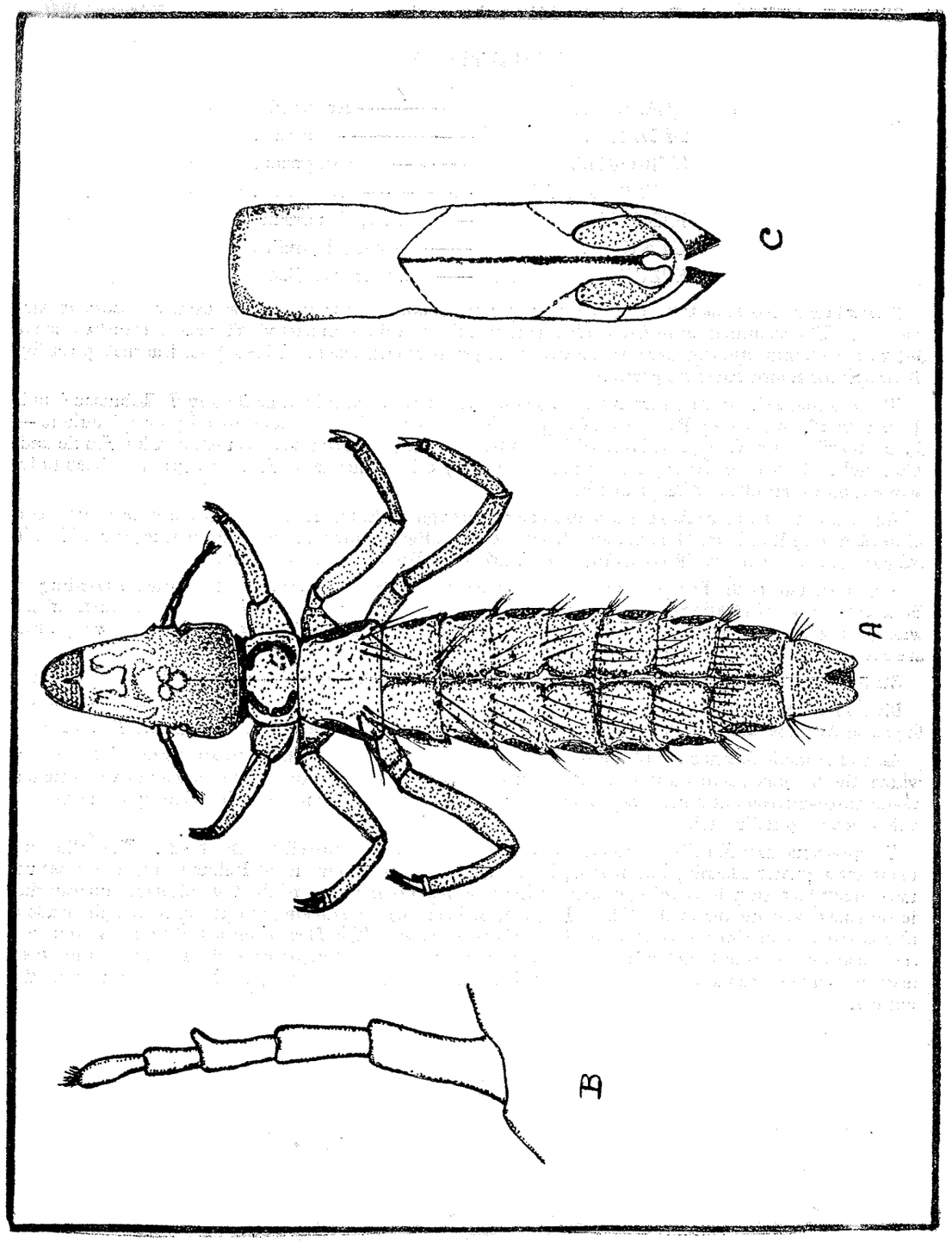
According to Clay[10] this genus contains in addition the following :—

A. stellare (Denny) from Botaurus stellaris stellaris.
A. ciconiae (Linn.) from Ciconia ciconia ciconia.
A. maculatum (Nitzsch & Giebel) from Ciconia nigra.
A. raphidum (Nitzsch & Giebel) from Plegadis falcinellus falcinellus.

Original Literature on these specimens has not been available to the writer, but an examination of the specimens of A. ardeae prepared by the late Mr. Bedford in the Onderstepoort laboratories helped in the identification of this material as *Ardeicola ardeae*. Bedford[5] recorded this specimen from Ardea cinerea in the Rustenburg District—Transvaal.

PLATE III.

A. — Adult of A. ardeae from dorsum.
B. — ..... Antenna of male.
C. — Genital organ of ♂ A. ardeae.



CHAPTER V.

CLASS .. .. : ————————Arachnida.
ORDER .. .. : ————————Acarina.
SUB-ORDER .. : ———— Mesostigmata.
SUPER-FAMILY : ———————— Ixodoidea.
FAMILY .. : —Argasidae, Canestrini.
GENUS .. .. : ——— Argas, Latreille.
SPECIES .. : —— A. persicus, Oken.

A number of Argasids were collected from the nests and the tree which was used as a roost by the Herons. The examination of the adult forms and the larval specimens which occurred on two hosts led to the identification of these specimens as Argas persicus, Oken. The key used is that given by Bedford[5] for South African species.

The internal and external anatomy of Argas persicus have been fully described by E. Robinson[11] and J. Davidson[9], and also by Patton and Cragg[15]. The life-cycle has been described by several authors—Lounsbury[16] in the Cape, and Nuttal[14] in Cambridge. Regeneration has been studied by Hindle and Cunliffe[13]. Its sensory perceptions, and the physiological significance of Haller's organ have been fully worked on by Hindle and Merriman[12].

According to Bedford[5] Argas persicus occurrs throughout South Africa, and has also been recorded from Southern Rhodesia, Mozambique, Belgian Congo, Egypt, Sudan, Algeria, Mauritius, part of North America, South America, Russia, Australia, Turkestan, Persia, India and China.

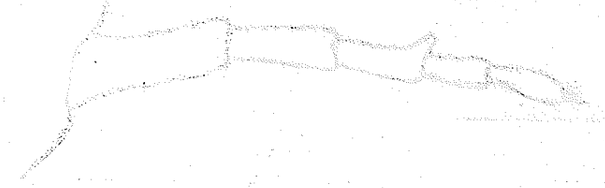
Argas persicus is chiefly a parasite of fowls but has been reported in several other birds. According to Bedford[5], Howard (1908) recorded it from Sagittarius serpentarius, and it has also been taken off the wild guinea-fowl, Numida papillosa transvaalensis, at Pienaar's River, Transvaal. The following birds are recorded by Bedford[5] to have been found with this parasite :—

Struthio spp.; Columbia livia domestica; Anas boschas; Meleagris gallapavo; and Anser domesticus.

Mr. Mokhehle whilst doing research work on avian parasites at Fort Hare, collected some larval forms of Argas persicus in 1946 from the Black Crow, Heterocorax capensis capensis, near Fort Hare.

As to the mode of infection of the roosts of the present hosts it is difficult to ascertain. The tree on which the heronry occurred was amongst houses, but in its vicinity the nearest fowl-run was situated about three-quarters of a mile away and the fowls certainly never came near the vicinity of the tree as this is near a girls' hostel.

There seems therefore but a slender chance that infection occurred via the fowls. The other inhabitants regularly sleeping and nesting in the same tree are specimens of Bulbucus ibis and it seems more likely that they have initially carried the parasites (as nymphs) to the tree and consequently the herons have become infected. These Egrets have been seen to run singly in the close neighbourhood of fowl-runs, sometimes very close to the fowls themselves. The Herons observed by me were never seen near fowl-runs although reliable information has been given that occasionally Herons venture very near the neighbourhood of poultry, and as this information may be correct the Heron itself may be the culprit.



CHAPTER IX.

TECHNIQUE

The host specimens after being shot were enclosed in a clean glass fumigating vessel, in which some Carbon bisulphide was introduced. The ectoparasites in this way died in situ and were then hand-picked. To collect more, the birds were defeathered on a white back-ground and then the parasites collected and preserved.

MALLOPHAGA : These are preserved in 70% alcohol. To make permanent preparations of the specimens the following procedure is adopted :—

The specimens are first heated in a 10% solution of potash in a test-tube for 10-15 minutes. After heating, the specimens are then transferred into distilled water and pricked with an entomological pin and then pressed with the head of the pin to expel the contents of the body that have not been washed out by the potash. The specimens are then dropped into 70% alcohol and passed up into 100% where they are left for 10-15 minutes. Bedford[5] suggests the use of clove-oil as a clearing agent, but xylol mixed with terpineol in the proportion of xylol : clove oil : : 2 : 1 was more satisfactory as clove-oil tended to contract the specimens severely. The specimens are then mounted in Canada balsam and examined by a microscope.

ACARINA : To preserve tampans in their natural colours, the prescription recommended by Mönnig for ticks has been adopted : A solution of 4% formaldehyde is shaken with a few drops of chloroform, more chloroform being added until saturation point is reached. The excess chloroform is then removed, and into the solution live ticks are dropped and the tube is stoppered air-tight for 3 months.

The examination of adult specimens is done mostly by incident light reflected tangentially which helps to accentuate surface irregularities. Perpendicular lighting is sometimes employed.

Theiler suggests that larvae should be cleared in glycerine and studied under the microscope after making permanent mounts with gum arabic. It was found, however, that glycerine tended to disfigure the specimens, the same method used for lice being followed with the larvae.

For procuring internal parasites, the internal organs were carefully examined with the help of magnifiers. Some organs, e.g. lungs, kidney, and liver were thoroughly teased out after a general examination and examined in normal saline between pressed slides under a dissecting microscope.

The contents of the intestine after removal from the alimentary tract were agitated with distilled water in a stoppered flask, allowed to settle partially and then decanted, the mother liquor being examined with binoculars. The residual precipitate was further agitated by centrifuging in glycerine medium and then examined on a slide with a low-powered microscope. The same procedure was employed in examining the contents of the gall-bladder.

The intestine after removal of the faeces, and obvious parasites, was further cut into short lengths and examined with a hand lens, and the mucosa scraped off into a dish of water and then examined for smaller parasites against a dark back-ground.

To detect any Filarial Nemas blood-smears were made and treated with Jenner's solution or with the Leishman Romanowsky stain.

NEMATODA : These when found alive were first examined in Ringer's solution with a low-powered microscope. This type of examination was found to be very useful as the specimens tend to become extremely opaque after fixation. In this state the cuticle is very transparent and with the movement of the eggs in the case of the females the exact disposition of the genital ducts is rendered more easily discernible. The Nematodes are then fixed in hot 70% and then preserved in this medium with 5% glycerine.

In examining such material it is necessary to use a clearing medium. 50% glycerine, as usually recommended, was at first used but this was later abandoned as it had the disadvantage of disfiguring the specimen though it did the clearing thoroughly. Langeron's lactophenol was then used, and al-

though this cleared the specimens well the details of the spicules in the male, and the disposition of the ovijector in the female could not be discerned. To render them more evident, beech-wood creosote was tried with great success. In using this the specimens are first transferred into 95% alcohol for 2-3 days to allow for a thorough penetration of this alcohol after which they are then transferred into the creosote. When clear they are then examined free on a slide by a low-powered microscope, and then when necessary rolled under a cover-slip on a slide.

After examination the creosote must be removed from the specimens as they tend to become very dark in colour if returned into the alcohol without removal of the creosotum. This is avoided by immersing the parasites in 2% acid alcohol (70%) solution for at least 8 hours after which they are transferred into the preserving medium.

In cases where certain details of internal anatomy were not observed, the Nematodes were opened out by means of needles and then rolled under a cover slip, on a slide.

All the measurements except that of the length of the Nemas were taken with the help of an ocular micrometer, the value of each of whose divisions had been previously calabrated. In the study of Nematodes great attention is attached to the relative lengths and widths of various parts of the entire animal. Two system of measuring Nemas, those of Cobb and de Man are in use. Cobb's system was followed.

In Cobb's system the measurements are from the anterior end to a given point and the width at each point is measured. Then the results, each as a percentage of the body length, are tabulated in two rows, the length above, the widths below, the body—length itself at the end in millimetres. The measurements are obtained by making a scale-drawing with a camera-lucida, giving the long axis as a line and the widths at the various points as short cross-lines.

The lengths measured are from the anterior and :—

(i) To the base of the pharynx or vestibule.
(ii) To the end of the oesophageal thickening.
(iii) To the vulva in females and the middle in males.
(iv) To the anus.

TREMATODA : These were first examined alive in normal saline and then fixed in Zenker's fluid in which they are left for 24 hours and then finally washed in running water. The fixed specimens are then preserved in 70% alcohol with 5% glycerine.

Toto-mounts were made using Borax carmine, Delafield's haematoxylin, and Ehlrich's acid haematoxylin.

For detailed anatomical study the material was embedded in paraffin wax and sectioned ; the best sections were found to be 10 microns in thickness. These were stained with haematoxylin and counter-stained with eosin in 90% alcohol. From such sections the detailed anatomy was then followed by reconstrueton.

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