IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

IFE, NIGERIA

1966

THE EXPLORATION BOARD

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THE IMPERIAL COLLEGE ZOOLOGICAL EXPEDITION TO NIGERIA, 1966

FINAL REPORT

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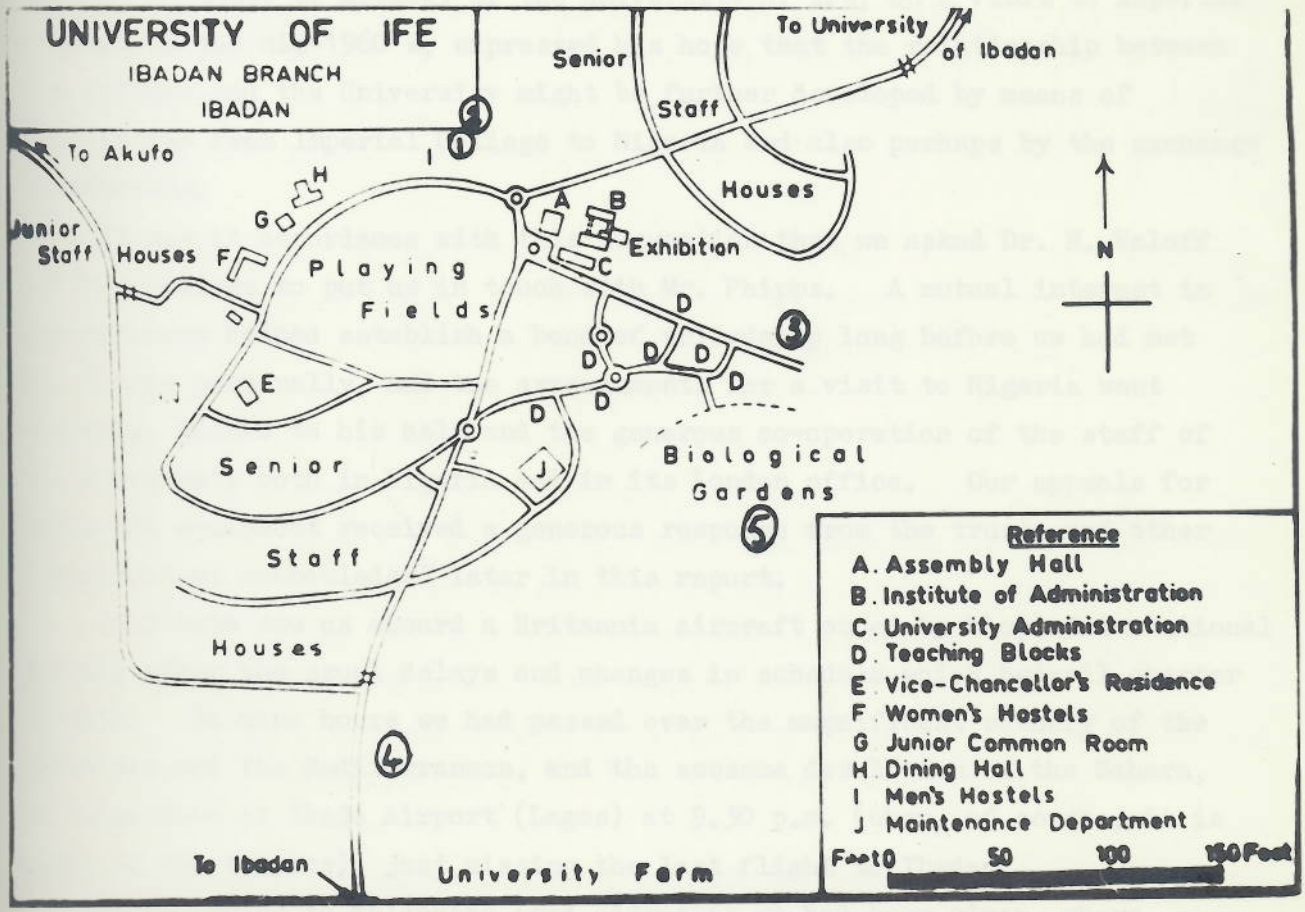

INTRODUCTION

There are strong links between the biological departments of Imperial College and those of the Nigerian Universities, chiefly through a truly international exchange of personnel. Nigeria, being the largest and most diversified of the English-speaking West African states, has been a natural first choice for expeditions from the United Kingdom. Mr. J. Phipps, the Acting Professor of Zoology of the University of Ife, on a visit to Imperial College in the mid-1960's, expressed his hope that the relationship between the College and the University might be further developed by means of expeditions from Imperial College to Nigeria and also perhaps by the exchange of students.

It was in accordance with this suggestion that we asked Dr. N. Waloff of this college to put us in touch with Mr. Phipps. A mutual interest in grasshoppers helped establish a bond of friendship long before we had met Mr. Phipps personally, and the arrangements for a visit to Nigeria went smoothly, thanks to his help and the generous co-operation of the staff of the University both in Nigeria and in its London office. Our appeals for funds and equipment received a generous response from the trusts and other organisations acknowledged later in this report.

July 14th saw us aboard a Britannia aircraft owned by Lloyd International Airways after the usual delays and changes in schedule which bedevil charter flights. In nine hours we had passed over the magnificent scenery of the Pyrennees and the Mediterranean, and the awesome desolation of the Sahara, to touch down at Ikeja Airport (Lagos) at 9.30 p.m. (when, of course, it is night in the tropics), just missing the last flight to Ibadan.

After trying to telephone some addresses we had been given, where inexpensive accommodation could be found, and having had little success in making the heavily overloaded Lagos phone system work, we met an Indian employee of Nigeria Airways who, on hearing of our predicament, at once suggested that we slept on the floor at his own house. His name, we found, was Tim Jevanjee, and we owe him and his charming wife our sincere thanks for the way in which they welcomed us and made us feel at home, both on this night and again when we were subject to a delay of three days on leaving Nigeria to return home.

The next day we hired a van to take us to Ibadan, the temporary home of the University of Ife. We little suspected that the ninety mile journey was to take nearly as long as the flight from London to Lagos. The van was subject to numerous delays on account of punctures, clutch trouble, and on one occasion an electrical fault. Finally the clutch ceased to engage at all and we were stranded. Two of the party were offered a lift by a passing European motorist and the rest of us paid off the van driver for £3. 10s. and piled into a local bus which took us to Ibadan for a pound. The bus itself ran out of petrol not far from Ibadan and had to buy some from a van which came by, but by then we had become used to the eccentricities of Nigerian transport! We were finally reunited at the University at 5 p.m., having set out at 9.30 a.m.

The University of Ife site at Ibadan is adjacent to the longer established University of Ibadan, a few miles from the town. Ibadan is the third largest town in Africa, with close on a million inhabitants. Because of its size and importance, it has piped water and 240 volt mains electricity. The University has its own facilities for alternative supplies of both commodities on the frequent occasions when municipal supplies fail. We stayed in the Halls of Residence of the University, where both European and Nigerian food was available. We arranged to have an evening meal each day and obtained the rest of our food from the local stores and the markets where fresh fruit is very inexpensive if one takes the trouble to bargain for it.

Much of the work described in the following pages was carried out at the University, though we were able to visit a variety of sites in the Western Region through the kindness of various members of the staffs of the Cocoa Research Institute of Nigeria and the Federal Departments of Forestry and Agricultural Research. In addition, through the generosity of the University authorities, we were able to pay two visits, each of about a week, to the University's Field Station, 280 miles to the North on the bank of the Niger. In the last week of our stay we were loaned a Landrover and the services of a driver by the University, to go on a short tour of Nigeria. This tour enabled us to see the great variety of Nigerian scenery and people, and to form some idea of the country as a whole. A brief account of the itinerary is included in this report.

MAP OF NIGERIA

During our stay in Nigeria, a number of significant political events occurred. A fortnight after we arrived, a swift and efficient military coup took place, resulting in the death of General Ironsi on a visit to Ibadan. Such was the effectiveness of the coup that the normal life of Ibadan was scarcely affected, beyond a curfew which lasted for a few days and made the collection of bats at night impossible. The new regime quickly released a number of political prisoners, among them Mr. Awolowo, the immensely popular Yoruba politician. Almost every Yoruba in Ibadan turned out on the streets to welcome him home. Our only other direct experience of internal politics was on our longer journeys, when our Landrover was stopped at the road-blocks on the regional borders and on the roads leading to the major cities. Despite the strong tribal feelings between Nigerians, there is no hostility towards 'expatriates' as foreigners are known, and we were never in any danger.

We left Ibadan two days before our plane was due to leave so that we might see something of Lagos. It is the only town in Nigeria which, to European eyes, looks like a modern city. In contrast to the rest of the country, its busy streets and modern buildings are most impressive. We stayed overnight in accommodation arranged for us by Mrs. Laddijobi, the mother of a staff nurse at the South London Hospital, where Sister Cox is employed. This hospitable lady cooked us meals in the compound she and her family shared with several others, hidden behind a row of shops and over-shadowed by a tall modern hotel. The following day she and her family showed us many of the places of interest in Lagos, until finally it was time for us to hire a taxi to take us to the airport to await our plane.

The plane did not come. It had developed engine trouble on the flight out and had turned back over the Sahara. Once again our good friend Mr. Jevanjee came to our aid, and some of us stayed at hime house while the others stayed at the Airport Hotel. Due to a breakdown of the Telex link with London, it was impossible to know when the plane was coming until it was in radio contact with Lagos. This necessitated periodic enquiries at the airport at three-hour intervals. To add to our troubles, the flight had been overbooked and a number of people, including one of our party, had been arbitrarily struck off the passenger list. This was finally sorted out, with his name returned to the list and the culprits in jail.

During the delay, delegates to a constitutional conference had been arriving in Lagos and an outbreak of terrorism, including a bomb attack on a hotel (not ours!) had resulted in considerable security precautions, including a cordon round the airport. In the departure lounge there was a particularly forbidding sub-machine gun on a tripod, contrasting oddly with the genial federal soldiers who manned it, refreshing themselves with Coca-cola. We met an old friend among them - a soldier who had discussed his English education with us while frisking us for arms near Lagos. Our plane arrived three days late, and at this moment the British High Commission saw fit to give us some helpful advice by telephone. Try not to stay in the airport buildings, they counselled, as if terrorists try to blow the place up the blast will be much worse indoors. Nothing of the sort happened, of course, but we were all greatly relieved when, at 3 a.m., we were airborne and bound for home.

ITINERARY OF THE TOUR OF NIGERIA

August 30th: Left Ibadan at 6.30 a.m. Drove to Zaria (530 miles) via Ilorin, Jebba, Kontagora, Kaduna. Overnight as guests of Miss Pauline Drew, a student of Bristol University collecting reptiles at Amadhu Bello University, Samaru (Zaria).

August 31st: Sightseeing in Zaria and Kaduna. Visited University. Second night as guests of Miss Drew.

September 1st: To Kano (110 miles). Visited famous Mosque, museum, market and dye-pits. Overnight at Hotel de France in the only room they had vacant. Rather cramped with seven people, but excellent food and prices very low.

September 2nd: To Jos (270 miles) via Bauchi. Breathtaking scenery, reminiscent of the Alps, on approach to Jos Plateau. Overnight at Catholic Mission School.

September 3rd: Sightseeing and insect collecting on Plateau. Remarkable candelabra-like succulent Euphorbias suggest aridity, but climate coolest anywhere in Nigeria. Potatoes and roses grown. On to Wamba (95 miles) in evening. Meal as guests of Nigerian District Officer who told us stories of Juju and mythical animals, obviously believing in both. Overnight at bush rest-house.

September 4th: To Enugu (280 miles) via Makurdi; progress slow on wet earth road until we reached Makurdi. Enugu a rich city, prices high. Overnight at catering rest-house named "Progress Hotel".

September 5th: Return to Ibadan (280 miles) via Onitsha, Benin City, Ife. Beautiful modern road bridge at Onitsha.

GENERAL INFORMATION

Essential Preliminaries

Passport.
Residence Permit (arranged by University of Ife).
International Driving Licence (arranged by A.A.).
Special Driving Licence (arranged by A.A.).
Yellow Fever Vaccination (Yellow Fever Centre).
Anti-Malarial Tablets (donated by Burroughs Wellcome).
T.A.B.T. Vaccination (by College Doctor).
Smallpox Vaccination (by College Doctor).

Living in Nigeria

Public transport is normally by taxi at about 2d. per mile.
240 volts A.C. electricity widely available.
Drinking water should be boiled.
Blood-flukes may be caught by standing in slow-running or salt water; B.C.G. vaccination said to give some protection!
Mosquito nets necessary; never scratch insect bites as sores develop.
Inexpensive accommodation provided by rest houses (marked on maps).
Food must be tightly sealed if ants are not to get into it.

FINANCES

The expedition was sponsored by the Imperial College Exploration Board who awarded £250 towards the £1,050 total. The remainder of the finances were covered by individual contributions of £60 plus donations from the following organisations to whom we are most grateful. The revised balance sheet is given below:-

	Items	Actual Expenditure £. s. d.	Estimated Expenditure £. s. d.
	1 x £65 1 x £98 6 x £85		
1.	TRANSPORT		
	Air Fare - London/Lagos/London	673. 0. 0.	673. 0. 0.
	Lagos/Ibadan/Lagos	20. 11. 0.	49. 7. 0.
	London/Gatwick/London	3. 17. 0.	
	Transport in Nigeria	49. 9. 1.	50. 0. 0.
2.	FOOD AND ACCOMMODATION		
	Ife University and Research Station 6 x 8 x £5 1 x 4 x £5	259. 5. 8.	260. 0. 0.
	3 day delay at Lagos airport	5. 11. 3.	
3.	EXCESS BAGGAGE	0. 5. 0.	10. 0. 0.
4.	POSTAGE OF SPECIMENS TO BRITISH MUSEUM	0. 0. 0.	5. 0. 0.
5.	EQUIPMENT		
	(a) Parasitologists	5. 10. 6.	20. 0. 0.
	(b) Entomologists	0. 18. 6.	5. 0. 0.
6.	FILMS - Colour Transparencies	8. 15. 8.	
7.	Phone Call to U.K. - 'planedelayed	5. 0. 0.	
8.	International driving licence	0. 17. 6.	
9.	INCIDENTAL EXPENSES		
	Report costs, including stamps, envelopes, phone calls, etc.	17. 5. 11.	40. 0. 0.
10.	Bank Fees - Ibadan/Kensington/Ibadan	1. 9. 0.	
		£1,051. 16. 7.	£1,112. 7. 0.

MONEY RECEIVED	£.	s.	d.
1 x £10 1 x £20 6 x £60			
PERSONAL CONTRIBUTIONS	390.	0.	0.
I. C. EXPLORATION BOARD	250.	0.	0.
FORD DAGENHAM TRUST	75.	0.	0.
WILLIAM JOHNSTON YAPP MEMORIAL TRUST	50.	0.	0.
GILCHRIST EDUCATIONAL TRUST	75.	0.	0.
BRITISH PETROLEUM	50.	0.	0.
ANTI LOCUST RESEARCH CENTRE	50.	0.	0.
ROYAL GEOGRAPHICAL SOCIETY	50.	0.	0.
ADDITIONAL CONTRIBUTIONS	15.	10.	0.
JOSEPH LUCAS CHARITABLE TRUST	5.	0.	0.
OWEN ORGANISATION	7.	7.	0.
WORSHIPFUL COMPANY OF GOLDSMITHS	75.	0.	0.
PULTNEY'S	5.	5.	0.
TOTAL INCOME:	£1,098.	2.	0.

We are also indebted to the following organisations for providing equipment and supplies:-

Admel International Ltd.
Baird and Tatlock Ltd.
Beecham Research Laboratories
British Drug Houses Ltd.
Gallenkamp Co. Ltd.
Gillette Surgical Co.
R. Glover Ashcraft Ltd.
Hawksley and Sons Ltd.
H. J. Heinz Co. Ltd.
Imperial Chemical Industries Ltd.
Johnson and Johnson Ltd.
Johnsons Ethical Plastics Ltd.
Littlewoods Ltd.
Marfae Polythene Co. Ltd.
Nestle Co. Ltd.
C. E. Payne and Sons Ltd.
Ronson Products Ltd.
Scientific Supplies Co. Ltd.
Smiths Industries Ltd.
Smith and Nephew Ltd.
Stayne Laboratories Ltd.
A. Wander Ltd.
Wellcome Foundation.

We should also like to thank the many who gave advice and assistance, especially:-

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Mr. B. Ing, of the Kindrogan Field Centre.

Mr. Lee, Ibadan, Nigeria.

The late Professor B. G. Peters of Imperial College.

Dr. D. Pye of Kings College, London.

Professor O. W. Richards of Imperial College, London.

Mr. D. Rosevear of the British Museum (Natural History).

Mr. A. Stephenson and the Imperial College Exploration Board.

Sir Boris Uvarov and the staff of the Anti-Locust Research Centre.

Dr. N. Waloff of Imperial College.

Finally, we must record our gratitude to the authorities and staff of Ife University for the generous help in so many ways, both domestic and scientific. In particular we wish to express our thanks to Mr. J. Phipps and Mr. J. I. Menzies of the Zoology Department for their valuable assistance and advice.

THE ENTOMOLOGY PROJECT

by

J.S.Badmin
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REPORT OF THE ENTOMOLOGICAL PROJECT

Introduction

The aim of this project was to obtain outline data on the ecological role of grassland Acridoids to facilitate a comparison of a tropical grasshopper population with similar temperate ones. In particular, those populations studied by Richards and Waloff (1954) were borne in mind as a standard for comparison. These latter studies, however, covered a period of five years whereas the present survey scarcely occupied as many weeks and so much be regarded only as a rather sketchy outline of the situation as we found it in July and August, 1966.

Most of the work was carried out on the campus of the University of Ife, Ibadan Branch, and some of the analysis of crop contents was performed on specimens obtained on a week's visit to the University's field station at Shagunu.

Ibadan, the largest city in West Africa, lies at approximately latitude 7° 27' N., longitude 3° 52' E. The University is about two miles from the outskirts of the town. Prevailing vegetation is semi-permanent arable, with regenerating secondary rain-forest in scattered patches. The rainy season lasts from May until October with in some years a slight lull in early August or late July.

Shagunu field station is close to the river Niger at 10° 20' N., 4° 27' E., in the "Guinea Savannah" zone. Shifting cultivation is practised, but at any given time most of thelandscape is wild grassland with frequent small, often leguminous, trees which may form closed canopy woodland in areas protected from fire. The rainy season is shorter here and the insect fauna is considerably different from that at Ibadan in the rain-forst belt.

The aspects of grasshopper ecology to which we directed our attention were as follows:- population density in a selected area; type and quantity of plants eaten; and natural enemies.

Photograph of the population study area showing the forest barrier and wall of the Hall of Residence

CHECK LIST OF SPECIES STUDIED

Table 1

Acanthacris ruficornis (Fab.)
Acrida turrita (L)
Atractomorpha aberrans Karsch
Cannula lincaris (Saussure)
Carydana agomena (Karsch)
Cantantops melanostictus (Schaum)
Cantantops spissus (Walk.)
Cantantopsilus Ramme sp.
Chirista compta (Walk.)
Chrotogonus senegalensis Krauss
Coryphosima producta (Walk.)
Dictyophorus oberthuri (Bolivar)
Eyprepocnemis plorans (Charpentier)
Epistaurus succineus (Krauss)
Gymnobothrus temporalis (Stal.)
Heteropternis thoracica (Walk.)
Humbe tenuicornis (Schaum.)
Morphacris fasciata (Thunberg)
Oedaleus nigeriensis (Uvarov)
Oxya hyla (Serville)
Pododula ancisa (Karsch)
Trilophidia conturbata (Walk.)
Zonocerus variegatus (L.)
Anacatantops notatus (Karsch)
Catantops pulcherrima
Orthochtha Karsch sp.
Paracinema tricolor (Thunberg)

POPULATION SURVEY

A grassy plot was selected on the University campus. The factors determining the choice of the area were:- (i) open aspects; (ii) delimitation by natural or artificial barriers not normally crossed by grasshoppers; (iii) freedom from human interference (e.g. football, mowing); (iv) accessibility. The plot chosen was almost flat and roughly rectangular, with an area of about 1,700 square metres. Of its 197 metric perimeter, 56 metres were arbitrary boundaries across which the grasshoppers could freely pass into considerable areas of similar grassland. Of the remainder, 103 metres were bounded by dense scrub and woodland and 38 metres by a low wall. The area was not overhung by any peripheral trees, but a single large tree was sited roughly in the centre.

On 12th August, the composition of the ground flora was investigated. Sampling was by means of a 25 cm. square wire quadrat, which was thrown at random fifty times and the plants in the area covered each time were recorded. Percentage cover was the character used to score the plants, as it was felt that this bore a reasonably close relationship to the amount of each plant available for the grasshoppers to feed on. The mean and maximum heights of the vegetation in each square were also estimated and recorded. Plants with coverage of less than 5% were scored as 'present'. In the tables (II) overleaf, the data are presented in two ways; first, the proportion of squares in which each species was found, giving an indication of how widespread each plant was; secondly, the percentage cover by the plant, giving a quantitative estimate of availability.

TABLE II

Number of Squares in which each Plant was present

Species			
Synedrella modiflora	38/50	=	0.76
Tridax procumbens	15/50	=	0.30
Desmodium triflorum	29/50	=	0.58
Commelina species	5/50	=	0.10
Other forbs	6/50	=	0.12
Cynondon dactylon	47/50	=	0.94
Aplismenus species	19/50	=	0.38
* Sedges	6/50	=	0.12
Paspalum commersonii	5/50	=	0.10
Other grasses	2/50	=	0.04
All forbs	49/50	=	0.98
All grasses and sedges	49/50	=	0.98

* Mariscus flabelliformis; Mariscus umbellatus; Cyperus sphacelatus.

TABLE III

Plant Species	Percentage Cover
Synedrella modiflora	20.05%
Tridax procumbens	6.70%
Desmodium triflorum	16.70%
Commelina species	0.60%
Other forbs	5.50%
Cynodon dactylon	41.08%
Paspalum commersonii	3.52%
Aplismenus species	2.95%
Sedges	0.86%
Other grasses	1.00%
Total forbs	49.55%
Total grasses	49.41%
Bareground and litter	1.20%

Height of vegetation:-

Mean of mean heights	15.6 cm.
Mean of maximum heights	34.6 cm.

About a dozen species of grasshopper were taken in the study area. The three commonest were selected for the population estimates. These were:-

Corydana agomena	Karsch
Spathosternum pygmacum	Karsch
Coryphacema centralis	(Rehn) (= C product

Other species which were taken every day were, in order of abundance:- Chirista compta; Epistauru succineus, and Eyprepocnemis plorans.

Population size was estimated by marking-recapture methods, the procedure being described below. Three people collected for about an hour at mid-day, catching about 300 adult grasshoppers in all, by sweeping the vegetation with butterfly nets, which were found to be superior for this purpose to the ordinary sweep-net with a heavy bag, as grasshoppers are more apt to escape from the latter pattern of net. The grasshoppers were put in 9" x 6" polythene bags in batches of about thirty and taken back to the laboratory for marking. The marked grasshoppers were placed in two cylindrical breeding cages and left there until the marking paint had dried. The cages were then carried back to the study area and the insects were released by shaking them out of the cages as the experimenters walked about the area.

The marking paint used was nail varnish, with an acetate base. The colours used were transparent, red and blue. Blue varnish was made by adding some of the parasitologists' Giensa stain to the colourless varnish. This faded to a milky white after a week in the field, but it was felt that with a suitable selection of more permanent dies a variety of coloured marking paints could be produced very cheaply by this method. The marks seemed fairly permanent in the field, but small flakes (not whole spots) of varnish were found in the polythene bags where the grasshoppers had been jostling each other. Freshly marked grasshoppers appeared to be in some discomfort until the paint had dried, especially where the mark had been applied to the head. They were seen attempting to clean the paint off with the fore-legs which very occasionally became covered with varnish. Fortunately, nail varnish is designed to dry rapidly. Once the paint was dry the insects did not appear to be inconvenienced by it.

As our marking technique improved, we were able to apply smaller spots and we found it possible to achieve daily differences in the marks by varying the position of the spot and not its colour. The marks were as follows:-

TABLE IV

Date	Colour	Position (all dorsal)
July 25	colourless	Centre of thorax
26	red	Centre of thorax
27	red	2 spots, each side of thorax
28	blue	Rear end of thorax
29	blue	Front of thorax

TABLE IV (Continued)

Date	Colour	Position (all dorsal)
August 1	red	Left of head behind eye
2	red	Right of head behind eye
3	red	Centre of head
4	red	Base of left elytron
5	red	Base of right elytron
10 - 24	Further recapture without remarking.	

As each grasshopper was marked, its species, sex and previous marking were recorded. These factors were also recorded for the few grasshoppers which died after being caught. The number of each sex of each species of grasshopper released was also recorded; in some cases this differed from the number captured due to deaths and escapes in the laboratory. Specimens already marked were remarked.

From data such as those obtained in this survey, it is possible to calculate the number of grasshoppers present by means of the 'Lincoln Index'. If, out of a population of N individuals, a have beenmarked, and b are captured of which c are found to have been marked, c should be the same fraction of b that a is of N (provided that b is a representative sample of the population). Expressed algebraically:-

$$\frac{c}{b} = \frac{a}{N}$$

From this, it follows that N, the figure for the total population, is given by the expression:-

$$\frac{a \times b}{c}$$

This is the Lincoln Index.

Bailey (1952) has shown that for a recapture of less than 10% of marked individuals, a better index is:-

$$\frac{a \times (b + 1)}{(c + 1)}$$

and it is this formula that is used below.

In early analyses of the data, considerable variation was found in the number given by the index for each species on different occasions. To reduce the variability of the data we investigated the possibility of treating the insects as a single population instead of regarding each sex of each species as a separate population. This is only possible if the component populations are stable. If one species is becoming more abundant or less abundant with respect to the others, the resulting change in the composition of the population will be reflected as a change in the proportions each species forms of the total catch. This cannot be used as an absolute measure of abundance, but only as a measure of the changes in relative abundance. For example, one species may be twice as easy to catch as another. The table that follows shows the percentages for each sex of each species of the total catch in weeks 1 and 2 and the catches on Wednesday of weeks 3 and 4.

TABLE V

Percentage Composition of Catch

	C. agomena		S. pygmaeum		C. centralis	
	male	female	male	female	male	female
Week 1	14.4	11.4	11.4	8.8	36.2	17.1
Week 2	13.8	12.1	13.6	8.8	35.1	16.3
Week 3	11.4	10.8	18.0	7.9	33.8	18.0
Week 4	11.2	9.0	16.3	8.6	36.1	18.9

In an ageing population of grasshoppers, there is a tendency for the females to die first, altering the sex ratio in favour of the males. The following table was prepared to show if the populations were ageing. The ratio given is the number of males per female.

TABLE VI

Sex Ratios

	C. agomena	S. pygmacum	C. centralis
Week 1	1.27	1.30	2.02
Week 2	1.14	1.54	2.17
Week 3	1.06	2.31	1.88
Week 4	1.24	1.99	1.91

In both these tables it must be borne in mind that the figures for weeks 3 and 4, each based on a single catch, are less reliable than those for weeks 1 and 2, based on five catches. On the basis of percentage catch it appears that S. pygmacum is replacing C. agomena, yet it is pygmacum that shows the increase in the ratio of males to females. Perhaps this is due to behavioural differences with a change towards wetter weather in the last two weeks, or perhaps it reflects a genuine demographical event. The variations in the properties of the species in each catch, though large, are no greater than the variations in the Lincoln index scores, so, with some misgivings, we treated the three species together as a single population.

The proportion of recaptures of any one day's marking will decline as time goes on. This is due to several factors acting together, namely:-

1. Emigration of marked insects from the area,
2. Immigration of unmarked insects,
3. Death of marked insects,
4. Moulting of nymphal insects to become adult in the area
5. Loss of marks.

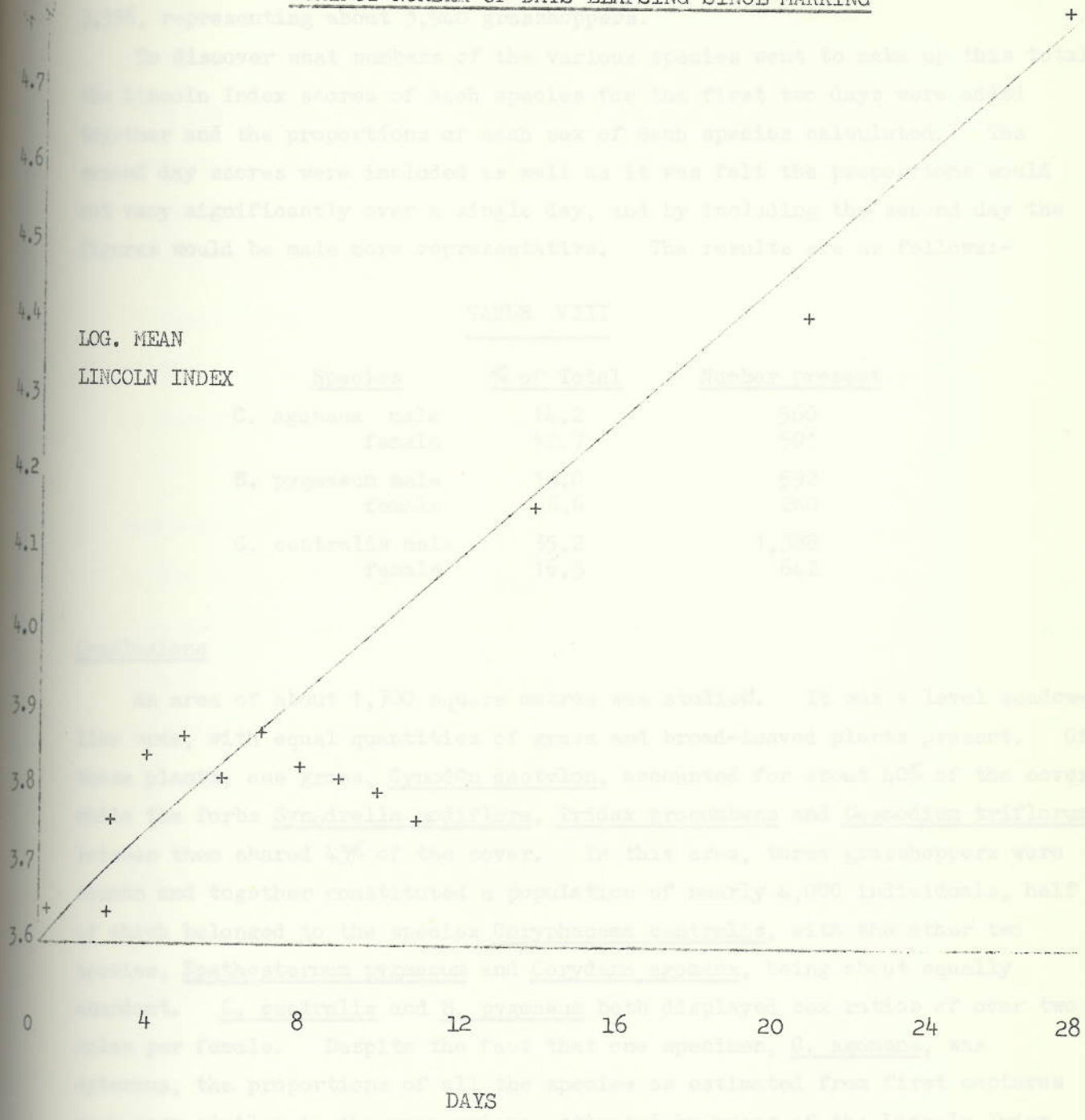
It is presumed that these factors will result in an exponential decline in the number of marked insects being recaptured. This will result in an exponential increase in the index. Accordingly, the data were plotted on a graph of logarithm of Lincoln Index figure against days after marking. The means of all the estimates after one day, after two days etc. up to eleven days were used; then the means of the estimates for the five days round the fourteenth day, the 21st day and the 28th day were used. These figures are set out below:-

TABLE VII

Total Population Estimate of the Three Species

Days after marking	Mean	Log. Value
1	4,432	3.646
2	4,437	3.647
3	5,636	3.751
4	5,787	3.832
5	7,288	3.863
6	6,359	3.803
7	7,326	3.865
8	6,464	3.810
9	6,332	3.801
10	5,892	3,778
11	5,658	3.753
12 - 16	14,128	4.150
19 - 23	24,672	4.392
26 - 30	49,608	4.695

GRAPH OF THE LINCOLN INDEX OF POPULATION SIZE
AGAINST NUMBER OF DAYS ELAPSING SINCE MARKING



The graph of these figures, extrapolated, gives an intercept at day 0 of 3.596, representing about 3,940 grasshoppers.

To discover what numbers of the various species went to make up this total, the Lincoln Index scores of each species for the first two days were added together and the proportions of each sex of each species calculated. The second day scores were included as well as it was felt the proportions would not vary significantly over a single day, and by including the second day the figures would be made more representative. The results are as follows:-

TABLE VIII

Species	% of Total	Number present
C. agomena male	14.2	560
female	12.7	501
S. pygmaeum male	15.0	592
female	6.6	260
C. centralis male	35.2	1,388
female	16.3	642

Conclusions

An area of about 1,700 square metres was studied. It was a level meadow-like area, with equal quantities of grass and broad-leaved plants present. Of these plants, one grass, Cynodon dactylon, accounted for about 40% of the cover, while the forbs Synedrella nodiflora, Tridax procumbens and Desmodium triflorum between them shared 43% of the cover. In this area, three grasshoppers were common and together constituted a population of nearly 4,000 individuals, half of which belonged to the species Coryphacema centralis, with the other two species, Spathosternum pygmaeum and Corydana agomena, being about equally abundant. C. centralis and S. pygmaeum both displayed sex ratios of over two males per female. Despite the fact that one specimen, C. agomena, was apterous, the proportions of all the species as estimated from first captures were very similar to the proportions estimated by means of the Lincoln Index.

EYPREPOCNEMIS PLORANS POPULATION

A number of species other than the three major ones were studied. E. plorans appeared regularly in the sweeps so a pilot investigation was begun. Specimens were marked, again with red varnish on the pronotal area but for individual recognition and released in the field after weighing and measuring.

The subsequent recapture of two individuals out of forty released, over a period of one week did not give a reasonable estimate. So the population size of about sixty was inferred by direct comparison with the three standard species.

The positive flying response of Acrida sp. to ones approach gave a visual estimate of not more than seven adults in the area. Of the eighty Chirista compta individuals in the area two different colour forms existed, brown being more common in males while females were equally green or brown. The sexes occurred equally throughout the study and no change in colour balance was noticed.

Two Zonocerus varegatus nymphs and four Oxya hyla adults were recorded, the former feeding on forbs during the latter half of the experimental period.

NYMPHAL POPULATIONS

A population estimate by the marking techniques used, could only be successfully applied to adult grasshoppers for nymphs regularly ecdysed and lost their varnish. To overcome this problem, specimens were marked, released and recaptured over a short time interval, but as results showed adults did not

disperse for at least a day this was discarded.

Even when several patches of grass were enclosed and all instars collected the numbers appeared to be too low. This method was compared with ordinary swept samples bearing in mind its extreme bias towards active individuals.

TABLE IX.

		I	II	III	IV	ADULT
CORYDANA AGRONEMA	sweep	14	10	13	6	3
	plots	-	2	1	7	2
SPATHOSTETHUN	sweep	2	8	6	3	4
PYGMAEUM	plot	-	1	-	3	1
CORYPHOCAEMA	sweep	13	19	12	14	18
PRODUCTA	plot	14	12	6	5	5

Since this bias was shown in the results these figures were only used for estimating the total amount of food eaten by grasshoppers.

CONTROL BY NATURAL ENEMIES.

i. PARASITISM

During examination of the crop contents several species of grasshoppers were found to be parasitized. Nematodes and dipterous larvae occurred in the body cavity, while gregarines were present in the gut. Large nematodes were identified as Mormis; at least two species of gregarine were present, the majority as sporadins, a few as cysts.

As is shown in table 9 Zonocerus was the grasshopper most heavily infected by gregarines. Zonocerus was common in swampy areas beside the Niger near Shaguna (area 7). Fewer adult Zonocerus were found to be parasitized simply because they were less abundant than the mymphs. Parasitism probably accounted for this.

All nematode infested grasshoppers came from area 2 (possibly with the exception of one Zonocerus from area 7). Maize, groundnut and Andropogon gaganus were the only plants peculiar to this habitat on the campas. These of the five species parasitized by nomatodes - C. producta, C. compta and Paracinema sp. - are grass feeders and therefore do not eat groundnut; the epidermal cells of Andropolon are very characteristic and easy to identify from crop contents, but were only found in the crops of C. compta and H. thoracica; maize was identified from the crops of these species C. compta, C. producta and Catantopsilus sp. a mixed feeder.

Unidentified grasses, which could have included maize, occurred in the crops of Paracinema sp. and H. thoracica. It is possible therefore that the neamtodes were associated with the maize.

Table 9

Species	Parasites: Gregarines	Mermithida	Other Nematoda	No. Parasitised	% Parasitised
C. pulcherrima	4 (7)	-	-	4	67
Catantopsilus sp.	-	2 (2)	4 (2)	6	86
C. compta*	-	1 (2) 1 (5)	1 (2)	3	9
C. agomena*	-	-	-	0	0
C. producta	-	-	8 (2)	9	12
E. plorans	1 (1)	-	-	1	3
H. thoracica	1 (2)	-	1 (2)	1G 1N	4G 4N
Paracinema sp.	-	-	1 (1)	1	9
S. pygmaeum	-	-	-	0	0
Z. variegatus	17 (7)	6	1 (7)	17G 1N	47G 3N

*C. compta: 1 Dipteran (Tachinid?) larva in area(2)

C. agomena 1 Dipteran (Tachinid?) larva in area (1)

Figures in parenthesis indicate the area from which the parasitised grasshoppers came.

2. PREDATORS

(a) Invertebrates

Various carnivorous insects were observed in the area studied. Of these, it is thought that a large and common Conocephaline Tettigonied and the larger mantids were likely to prey on grasshoppers, especially upon the nymphal stages. Some small black ants were observed feeding on a female Epistaurus succineus, though it is not known whether they killed it. Many other ants were observed on the campus, including driver ants in the less shady parts of the Biological Garden. Many Reduviid bugs and Odonata were seen, and a few Ascalaphid Neuroptera. A male Spathosternum pygmaeum was found caught in a spider's web. Asilid Diptera were common.

(b) Vertebrates

Possible vertebrate predators seen were birds and small mammals (although neither were encountered by us in the main study area), and the abundant toads and lizards.

A few preliminary experiments on the acceptability of grasshoppers as food were undertaken with two species of lizard and a toad. These are set out below:-

PREDATOR - TOAD (BUFO S P.)

Grasshoppers presented	Corydana	Spathosternum	Coryphacema
Nos. introduced	1 male	3 male, 1 fem.	2 male
Nos. remaining after one night	-	1 male	1 male
Presumed eaten	1 male	2 male, 1 fem.	1 male

PREDATOR - BLUE-TAILED SKINK

Species presented	Corydana	Spathosternur	Coryphacema
Introduced	2 male, 1 fem.	2 male, 2 fem.	2 male, 1 fem.
Remaining after 48 hours	1 male	2 female	-
Presumed eaten	1 male, 1 fem.	2 male	2 male, 2 fem.

PREDATOR - LIZARD (AGAMA AGAMA); ADULT MALE

Species presented	Corydana	Spathosternum	Coryphacema
Nos. introduced	2 male, 1 fem.	3 male, 2 fem.	2 male
Remaining after 24 hours	1 male	-	-
Presumed eaten	1 male, 1 fem.	3 male, 2 fem.	2 male

PREDATOR - AGAMA: adult male and juvenile

Species:	Corydana	Spathosternum	Coryphacema
Introduced:	5 m., 5 f.	5 m., 5 f.	5 m., 5 f.
Remaining after 48 hours	-	1 m., 1 f.	3 m., 1 f.
Presumed eaten	5 m., 5 f.	4 m., 5 f.	2 m., 4 f.

The results suggest that all three species are acceptable to all the predators tested. The more agile Coryphacema seems better able to elude Agama than the more sluggish Corydana.

B. FOOD PREFERENCES OF SOME ACRIDID GRASSHOPPERS

i. ANALYSIS OF CROP CONTENTS

INTRODUCTION. The majority of grasshoppers whose crops were analysed were caught on various parts of the University campus. The crop contents were identified as far as possible to plant species. Where this was not possible, the contents were identified as either grass or forb.

AREAS OF CAPTURE. The five areas on the campus where grasshoppers were taken are shown on the map. The occurrence of grasshopper and plant species in all areas is shown in tables 11 and 12.

AREA 1. The grassy patch on which the population survey was carried out plus a similar grassy patch adjacent to it. The relative abundance of plants in this area is described in part A. It should be noted that grasshoppers were not taken from this area for crop analysis until the population survey was complete.

2. A small cultivated field of cassava, groundnut and ripe maize. These three crops were planted mixed in the same rows. Adjacent to the crops was a large patch of prickly grass, doubtfully identified as Andropagon gaganus.

3. A grassy patch, its flora similar to that of area 1. but approximately one third the size.

4. A cultivated field overgrown by a species of Vigna and an unidentified forb A.

5. The Biological gardens, a large area with a varied flora. Few grasshoppers were caught here and no attempt was made to list the flora.

6. An experimental cotton and groundnut plot belonging to the Ministry of Agriculture. This was at Ilora, near the northern boundary of the Western province.

7. Area 7 includes all environs of the University of Ibadan field station near Shagunu in Northern Nigeria.

SAMPLING. Grasshoppers were caught by hand or random sweeping.

IDENTIFICATION OF PLANTS. Plants on the University campus were identified by the head gardener. Pressed and dried specimens were brought back and re-identified at Kew Gardens by Mr. S. S. Hooper, Dr. W. D. Clayton and J. S. Frost.

METHOD OF MAKING PERMANENT PREPARATIONS OF PLANT EPIDERMIS.

Pieces of upper and lower leaf epidermis, leaf edge and stem epidermis were peeled off and bleached in sodium hypochlorite for 10 - 30 minutes. These pieces were then washed in distilled water, dried in 50% alcohol and mounted in polyvinyl lactophend.

ANALYSIS OF CROP CONTANTS.

The plant fragments from the crops were placed on a slide, teased out in water and examined under high power. Identification of these fragments was made by systematic comparison with the epidermis preparations. Characters such as shape and size of hairs, and the cell size were used.

TABLE 10.

DISTRIBUTION OF GRASSHOPPER SPECIES

GRASSHOPPER SPECIES	AREAS						
	1	2	3	4	5	6	7
CORYPHOCAEMA PRODUCTA	/	/	/	/	/		/
SPATHOSTERNUM PYGMAEUM	/	/	/	/			/
CORYDANA AGRONEMA	/		/				
CHIRISTA COMPTA	/	/		/	/		
EYPREPOCNEMIS PLORANS	/	/	/	/	/		
CATENTOPS MELANOSTICTUS	/	/		/	/		
CATENTOPS SPISSUS	/	/		/			/
CATENTOPS PULCHERIMA							/
ZONOCERUS VARIEGATUS		/					/
ACRIDA TURRITA	/		/	/			/
EPISTAURUS SUCCINEUS	/	/		/			
HETEROPTERNA THORACICA		/		/	/		/
CANNULA LINEARIS		/					
MORPHACRIS FASCIATUS	/	/	/	/			
PARACINEMA SP.				/			/
ATRACTOMORPHA ABERRANS	/			/			
HUMBE TENUICORNIS		/					
ACANTHACRIS RUFICORNIS				/			
DNOPHERULA DESCAMPSIA							/
ANACATANTOPS NOTATUS		/		/			/
CATANTOPSILUS SP.		/		/			
PYCNODYCTIA DILUTA							/
ORTHOCTHA							/
CHROTOGONUS SENEGALENSIS						/	

TABLE 10. continued

GRASSHOPPER SPECIES	AREAS						
	1	2	3	4	5	6	7
TRILOPHIDIA CONTRABATA		/		/			
CEDALEUS NIGERIENSIS		/					
OXYA HYLA		/					
DICTYOPHORA OBTURI							/
PODULA ANCISA		/					
GYMNOBOTHRIS TEMPORALIS							/

TABLE 11.

DISTRIBUTION OF PLANT SPECIES

PLANT SPECIES	AREAS				
	1	2	3	4	6
TALINUM TRIANGULARE	/		/		
TRIDEX PROCUMBENS	/		/		
SPIGELIA ANTHELMA			/		
DESMODIUM TRIFLORUM	/		/		
VIGNA SP.				/	
SYNEDRELLA NODIFLORA	/		/		
VERNONIA CINERIA			/		
COMMELINA SP.	/		/		
MELANTHERA SCANDENS					
ARACHIS HYPOGAEA (GROUNDNUT)		/			/
GOSSYPIUM HIRSUTUM (COTTON)					/
MANIHOT ESCULENTA (CASSAVA)		/			
MARISCUS FLABELLIFORMIS	/				
MARISCUS UMBELLATUS	/				
CYPERUS SPHACELATUS	/		/		
CYONODON DACTYLON	/		/		
CHLORIS PILOSA			/		
SETARIA LONGISETA	/		/		
DACTYLOTENIUM AEGYPTIUM			/		
PANICEUM MAXIMUM			/		
PASPALUM COMERSONII			/		
PASPALUM CONJUGATUM	/		/		
BRACHIASIA DEFLEXA	/	/			
APLISMENUS SP.	/				
* ANDROPOGON GAGANUS		/			
ZEA MAYS (MAIZE)		/			

* IDENTIFICATION DOUBTFUL

ANALYSIS OF RESULTS. Was according to Brusven and Mulkern 1962.

FOOD PLANTS UTILIZED determined by crop analysis and recorded as the percentage of individuals of a particular species with a plant in their crops.

TOTAL INGESTION, the sum of the individual plant ingestion percentages. This indicates the proportion of species with more than one plant in their crops and feeding behaviour.

NUMBER OF PLANT SPECIES UTILIZED, a measurement of selectivity of a species.

GRASS-FORB INDEX, determined by subtracting the percent of a species with grass or sedge in the crop from the percentage with forbs. A positive number indicates a forb feeder, a negative number indicates a grass feeder.

PLANT SPECIFICITY INDEX determined by multiplying the percent ingestion of the most preferred plant by 3, the second by 2 and the third by 1, adding the quotients and dividing by 3. A figure approaching 100 indicates great selectivity. This parameter was only calculable for Cannula linearis since a large proportion of plant fragments were unidentifiable.

In addition comparison of total percent ingestion for each plant species with the number of grasshopper species attacking it indicates whether a particular plant is eaten in large or small amounts. By ocular estimate total plant ingestion is also indicative of its abundance.

CORYDANA AGRONEMA (Karsch).

69 specimens were dissected of which 27 had empty crops. 9 plant species were identified.

PLANT SPECIES	PERCENT INGESTION	
CYPERUS SPHACELATUS	2.4	
BRACHIASIA DEFLEXA	4.8	
CYONODON DACTYLON	36	
APLISMENUS SP.	4.8	
UNIDENTIFIED GRASSES	43	(14.45)
VERNOMIA CINERIA	2.4	
COMMELINA SP.	2.4	
SYNEDRELLA NODIFLORA	2.4	
UNIDENTIFIED FORBS	7.1	(4.8 A)

Total ingestion was 105.3% indicating that usually one plant species was ingested at a time. The grass-forb index was -75.7 indicating that C. agronema is a mixed feeder that prefers grass.

CORYPHOCAEMA PRODUCTA (Rehn).

A total of 70 crops were analysed, 10 of these were empty. Nine plant species were identified.

PLANT SPECIES	PER CENT INGESTION
MARISCUS PLABELLIFORMIS	5.0
MARISCUS UMBELLARUS	6.6
CYPERUS SPHACELATUS	15.0
SETARIA LONGISITA	5.0
BRACHIASIA DEFLEXA	11.6
CYONODON DACTYLON	3.3
ZEA MAYS	3.3
UNIDENTIFIED GRASSES	50.0 (3.3 S)
COMMELINA Sp.	1.6

The total ingestion was 101.4% indicating that only one plant species was ingested at a time. The grass-forb index was -96.3 indicating that Cocyphocaema was a grass feeder.

SPATHOSTERNUM PYGMAEUM (Korsch)

A total of 48 specimens were dissected, four of these were empty. Eight plant species were identified.

PLANT SPECIES	PER CENT INGESTION
MARISCUS FLABELLIFORMIS	6.8
MARISCUS UMBELLATUS	2.3
CYPERUS SPHACELATUS	9
SETARIA LONGISETA	2.3
BRACHIASIA DEFLEXA	2.3
CYONODON DACTYLON	39.1
APLISMENUS Sp.	11.4
PASPALUM COMMERSONII	4.5
UNIDENTIFIED GRASSES	22.7
UNIDENTIFIED GRASS SEED HEADS	6.8
UNIDENTIFIED FORBS	2.3

The total ingestion was 109.5% indicating that for about one-tenth of the time this species fed on more than one plant at a time. The grass-forb index was -95.4 indicating that this species is a grass feeder.

ACRIDA TURRITA (L)

A total of 34 specimens were dissected, 3 of which had empty crops. 4 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
MARISCUS UMBELLATUS	3.2
CYONODON DACTYLON	12.7
CHLORIS PILOSA	3.2
PANICEUM MAXIMUM	3.2
UNIDENTIFIED GRASS	76.8

The total ingestion was 99.1% indicating that this species fed on 1 plant at a time. The grass-forb index was -100 indicating that Acrida fed solely on grasses.

CATENTOPS PULCHERIMA

6 specimens were dissected and the crop contents identified as grass or forb.

PLANT	PERCENT INGESTION
GRASS	50
FORBS	50

Total ingestion was 100% indicating that only grass or forb was infested at any one time. The grass-forb index was 0 indicating that this specis was a mixed feeder.

ACANTHACRIS RUFICORNIS.

Seven specimens wereddissected, two plant species, one of which was identified, were found in the crops.

PLANT SPECIES	PER CENT INGESTION
VIGNA sp.	100
UNIDENTIFIED FORB A.	100

The total ingestion was 200 indicating that this species ingests more than one plant species at a time. The grass-forb index was 100 indicating that Acanthacus fed on forbs exclusively.

DICTYOPHORA OBTURI

One specimen was dissected whose crop contained grass.

PODULA ANCISA

Two specimens were dissected, both of whose crops contained Andropogon goganus. Total ingestion was 100% indicating that one plant species is ingested at a time, and the grass forb index 100, indicating a grass feeder.

GYMNOBOTHRIS TEMPORALIS

One specimen was dissected whose crop contained grass.

CATENTOPS MELANOSTICTUS (Schaum)

19 specimens were dissected, 4 of which were empty. 6 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
COMMELINA SP.	13.4
TRIDAX PROCUMBENS	6.7
VIGNA SP.	6.7
SYNEDRELLA NODIFLORA	6.7
ARACHIS HYPOGAEA (GROUNDNUT)	6.7
TALINUM TRIANGULARE	6.7
UNIDENTIFIED FORBS	67.0 (6.7 A)

Total ingestion was 113.9% indicating that in one out of ten times more than one plant species was ingested. The grass forb index was 100 indicating that this species fed on forbs only.

CATENTOPS SPISSUS. SPISSUS. (Walk)

14 specimens were dissected of which 4 had empty crops. 5 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
UNIDENTIFIED GRASSES	10
VIGNA SP.	30
ARACHIS HYPOGAEA (GROUNDNUT)	20
VERNONIA CINERIA	10
UNIDENTIFIED FORB A.	20

Total ingestion was 110 suggesting that in one out of ten times more than one plant species was ingested at a time.

The grass forb index was 90 indicating that this species was a forb feeder.

CEROTOGONUS SENEGADENSIS SENEGALENSIS

Five specimens were dissected, one of which had an empty crop. Vegetable matter was identified as grass or forb.

PLANT	PER CENT INGESTION
GRASS	25
FORB	75

Total ingestion was 100% indicating that grass and forb were not eaten at the same time. The grass-forb index of 50 indicated Chrotogonus as a mixed feeder but preferring forbs.

EPISTAURUS SUCCINBUS (Krauss)

A total of 22 crops were analysed. Two plant species were identified.

PLANT SPECIES	PER CENT INGESTION
UNIDENTIFIED GRASSES	13.5
TRIDAX PROCUMBENS	18.0
SYNEDRELLA MODIFLORA	40.5
UNIDENTIFIED FORBS	36.0 (31.5 A)

The total ingestion was 108.0% indicating that only one plant species was ingested at a time, The grass-forb value was 81.0 indicating that Epistaurus is a grass feeder.

CHIRISTA COMPTA. (Walk)

A total of 36 crops were analysed, eight of which were empty. Five plant species were identified.

PLANT SPECIES	PER CENT INGESTION
SETARIA LONGISETA	3.6
APLISMENUS sp.	21.4
ZEA MAYS	3.6
PASPALUM CONJUGATUM	7.2
ANDROPOGON GAGANUS	7.2
UNIDENTIFIED GRASSES	54.0 (39.6 S)
GRASS SEED HEADS	3.6

The total ingestion was 100.6% indicating that this species fed on one plant at a time. The grass-forb index was 100 indicating that Chirista fed exclusively on grasses.

EYPREPOCNEMIS PLORANS IBANDANA. (Giglio-Tes)

34 Specimens were dissected, of which 7 had empty crops. 7 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
SETARIA LONGISETA	7.4
APLISMENA SP.	3.7
UNIDENTIFIED GRASSES	22.2
COMMELINA SP.	7.4
TRIDAX PROCUMBENS	7.4
VIGNA SP.	3.7
SYNEDRELLA NODIFLORA	18.5
ARACHIS HYPOGAEA (GROUNDNUT)	3.7
UNIDENTIFIED FORBS	18.5 (7.4 A)
GRASS SEED HEADS	18.5

The total ingestion was 92.5% indicating that this species fed on one species at a time. The grass-forb index was 33.3 indicating that Eyprepocnemis is a mixed feeder but prefers forbs.

HETEROPTERNA THORACICA (Walk.)

23 specimens were dissected, of which two had empty crops. Five plants species were identified.

PLANT SPECIES	PER CENT INGESTION
APLISMENUS sp.	4.3
BRACHIASIA DEFLEXA	24.0
ANDROPOGON GAGANUS	9.6
UNIDENTIFIED GRASS	14.4
GIVNA sp.	9.6
ARACUIS HYPOGAEA (Groundnut)	24.0
UNIDENTIFIED FORBS	9.6 (4.8 A)

The total ingestion was 106.0% indicating that one plant species was ingested at a time. The grass forb index was 14.2 indicating that this species is a mixed feeder.

PYCNODYCTIA DILUTA

Four specimens were dissected, all contained grass in the crops. The grass-forb index was therefore 100 indicating a grass feeder.

ORTHOCTHA

Four crops were analysed, all contained grass.

MORPHACRIS FASCIATUS. (Thurb.)

Crops of 13 specimens were dissected out of which one was empty. 2 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
CYPERUS SPHACELATUS	16.6
CYONODON DACTYLON	8.3
UNIDENTIFIED GRASS	66.6 (25 S.)
UNIDENTIFIED FORB.	8.3

Total ingestion was 99.8 indicating that only one plant specis is ingested at a time. The grass-forb index was -83.0 indicating that Morphacris is a grass feeder.

HUMBE TENUICORNIS (Schacim)

9 crops were analysed and 2 plant specis identified.

PLANT SPECIES	PERCENT INGESTION
ZEA MAYS	11.1
ANDROPOGON GAGANUS	33.3
UNIDENTIFIED GRASSES	88.8 (11.1 S)

The total ingestion was 133.2% indicating that three out of ten times this specis infests more than one plant at a time. The grass-forb index was -100 indicating that it was solely a grass feeder.

TRILOPHIDIA CONTRABATA

3 Crops were analysed, one of which was empty. The same unidentified forb was present in the other crops. The grass forb index therefore was 100.

OEDALEUS NIGERIENSIS (Uvarov)

2 specimens were dissected, the crops of both contained grass, one also contained seed heads. The grass forb index was -100.

OXYA HYLA

1 specimen was dissected; its crop contained Andropogon gaganus and a trace of maize. The total ingestion was therefore 200% indicating that more than one plant specis may be eaten at a time. The grass-forb index was -100 indicating a grass feeder.

CATANTOPSILUS SP.

7 specimens were dissected, 2 of which had empty crops. 2 plant species were identified.

PLANT SPECIES	PERCENT INGESTION
ZEA MAYS	20
ARACRIS HYPOGAEA (GROUNDNUT)	80

The total ingestion was 100% indicating that only one plant species is ingested at any one time. The grass-forb index is 60 indicating a mixed feeder that prefers forbs.

ZONOCERUS VARIEGATUS (L)

39 crops were analysed, one of which was empty. Vegetable matter was identified as either grass or forb.

PLANT	PERCENT INGESTION
GRASS	36.9
GRASS SEED HEADS	5.3
FORB	87.4

The total ingestion was 124.3% indicating that, in two out of ten cases Zonocerus fed on grass and forb at the same time. The grass-forb index was 50.5 indicating that this species was a mixed feeder that preferred forbs.

ANACATATOPS NOTATUS (Karsch).

9 specimens were dissected, one of which was empty. 1 plant specis was identified.

PLANT SPECIES	PERCENT INGESTION
SYNEDRELLA NODIFLORA	12.5
UNIDENTIFIED FORBS	87.5 (25 A)

Total ingestion was 100% indicating that one plant species is ingested at a time. The grass-forb index is 100 indicating that Anacatatops is a forb feeder.

CANNULA LINERIS (Saussure)

18 specimens were dissected of which one had an empty crop. Only one grass species was present in the crops.

PLANT SPECIES	PER CENT INGESTION
ANDROPOGON GAGANUS	100

The total ingestion, grass forb index and plant specificity index were 100% and -100 and 100 respectively indicating that Cannula was highly specific to Andropogon gaganus.

TABLE 12.

SUMMARY OF RESULTS

	NO. OF INDIVIDUALS	NO. OF PLANT SPECIES IDENTIFIED	TOTAL INGESTION	GRASS FORB INDEX
CORYPHOCAEMA PRODUCTA	60	9	101.4	-96.8
SPATHOSTERNUM PYGMAEUM	44	8	109.5	-95.4
CORYDANA AGRONEMA	42	7	105.3	-75.7
CHIRISTA COMPTA	28	5	100.6	-100
EYPREPOCNEMIS PLORANS	27	7	92.5	33.3
CATENTOPS SPISSUS	10	3	110	90
CATENTOPS MELANOSTICTUS	15	6	113.9	100
ACRIDA TURRITA	31	4	99.1	-100
HETEROPTERNA THORACICA	21	5	106	-14.2
EPISTAURUS SUCCINEUS	22	2	108	81
MORPHACRIS FASCIATUS	12	2	99.8	-83
CANNULA LINEARIS	17	1	100	-100
HUMBE TENUICORNIS	9	2	133.2	-100
CATANTOPSILUS SP.	5	2	100	60
ZONOCERUS VARIEGATUS	38	0	124.3	50.5

TABLE 13.

	NO. OF GRASSHOPPER SPECIES ATTACKING IT.	PERCENT INGESTION
TALINUM TRIANGULARE	1	0.34
TRIDAX PROCUMBENS	3	1.7
VIGNA SP.	5	7.9
SYNEDRELLA NODIFLORA	6	5.0
VERNONIA CINERIA	2	0.65
COMMELINA SP.	4	1.3
ARACHIS HYPOGAEA	5	7.1
MARISCUS FLABELLIFORMIS	2	0.62
MARISCUS UMBELLATUS	3	0.48
CYPERUS SPHACELATUS	4	1.7
CYONODONDACTYLON	5	5.2
CHLORIS PILOSA	1	0.17
SETARIA LONGISETA	4	0.92
PANICEUM MAXIMUM	1	0.17
PASPALUM COMERSONII	1	0.24
PASPALUM CONJUGATUM	1	0.38
BRACHIASIA DEFLEXA	4	2.2
APLYSMENUS SP.	5	2.6
ANDROPOGON GAGANUS	6	18.5
ZEA MAYS	5	7.4
* UNIDENTIFIED GRASSES	7	6.2
* UNIDENTIFIED FORB A	8	12.5

* ALTHOUGH UNIDENTIFIED THESE TWO PLANTS ARE INCLUDED BECAUSE OF THEIR ABUNDANCE AND THE FREQUENCY WITH WHICH THEY WERE ATTACKED.

DISCUSSION

The majority of grasshoppers studied appeared to feed on a wide variety of plant species whether grasses, forbs or both. The plants attacked probably depends to a large extent on the plants available, enabling many species to have a wide distribution (compare species occurring in areas 1 - 5 with those in area 7, table 10.)

Comparison of grass-forb indices for species in this survey with percent grass and forb eaten by the same species as determined by Chapman in 1964, supports the idea that some specis are adaptable: Zonocerus varigatus Chapman found to be a forb feeder that preferred forbs Heteropterna thoracica was found by Chapman to be a grass feeder but here to be a mixed feeder preferring grasses.

On the other hand Cannula linnearis appeared to be highly specific to Andropogon gaganus and was limited to the particular part of the campus where this plant grew. Though specific Cannula must have other host plants since those studied by Chapman were not 100% graminivorous.

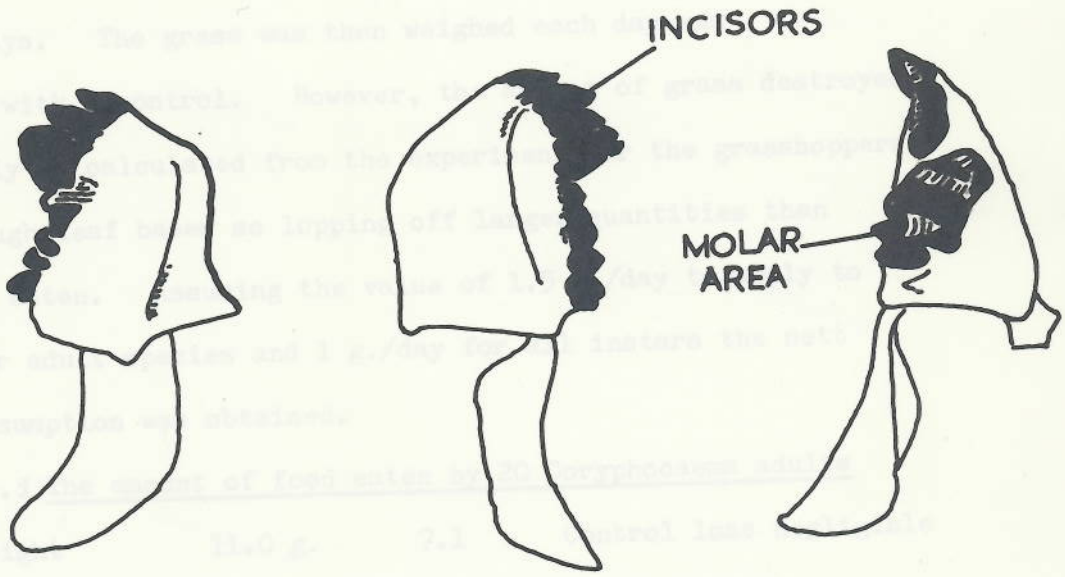
Those species with a wide distribution and wide range of food plants are more likely to attack a crop when brought into fresh contact with it than those with a more limited range of food plants, and could become economically important.

Mandibular form.

Since Isely (1938, 1944) showed that grasshopper mandibles were closely correlated with diet, specimens were kept for comparison with the crop analysis. Mandibles were only classified into forbivorous, graminivorous or intermediate (mixed) as the other types described by Isely were not encountered. A well developed pair of forbivorous, mandibles(C. spissus) are shown in the diagram below. Many individuals when dissected were found to have well worn mandibles.

Species	Mandibular type
Zonocorus variegatus	forbivorous
Catentops spissus	"
C. melanostictus	"
Eyprepocnemis plorans	intermediate
Spathosternum pygmaeum	graminivorous
Corydana agronema	"
Coryphocaema producta	"
Chirista compta	"
Cannula linearis	"
Catantopsilus sp.	"
Anacatantops notatus	"
Acrida turrita	"
Epistaurus succineus	"
Morphacris fasciatus	"
Humbe tenuicornis	"
Heteropterna thoracica	"
Oedaleus nigeriensis	"
Trilophidia contrabata	"

DIAGRAM OF MANDIBLES



CATANTOPS SPISSUS

Food Consumption

After basic food preferences of the three major species had been analysed it was decided that the total amount of grass eaten should be estimated.

Twenty Coryphocaema producta adults were introduced into a large breeding cage with a weighed sample of grass for a period of two days. The grass was then weighed each day and compared with a control. However, the amount of grass destroyed could only be calculated from the experiment for the grasshoppers bit through leaf bases so lopping off larger quantities than they had eaten. Assuming the value of 1.5 g./day to apply to the other adult species and 1 g./day for all instars the nett food consumption was obtained.

Table 14.i The amount of food eaten by 20 Coryphocaema adults

Grass weight	11.0 g.	7.1	Control loss negligible
after 1 day's feeding	9.5 g.	5.7	
amount destroyed	1.5 g.	1.4	

Table 14.ii

Species	Mean population value.	Ratio of nymphs to adults	Nymphal value
Corydana	666	53.5 adults	12050
	471		
Spathosternum	630	23.5	3942
	227		
Coryphocaema	1787	95.23	10070
	652		
Total	4433		26062

Grass destroyed $\frac{4433}{20} \times 1.5 + \frac{26,062}{20} \times 1.0 = 1.636$ kg./day

Since the survey area was 1,400 sq. metres 4.73 Kg./acre/day

Annual loss per acre = 1.8 tons

When this loss is compared with an average yield of 6 - 8 tons wet weight per acre from a similar habitat in Britain the damage caused by grasshoppers can be seen to be of considerable economic importance.

APPENDIX 1.

COLOUR VARIATION OF SPATHOSTERNUM PYGMAEUM AND CORYPHOCAEMA PRODUCTA

These two species showed variation in colour of their dorsal parts - the pronotum and top of the tegmina. They were handled in sufficient numbers during the population survey to note the proportions of each form.

All S. pygmaeum males were brown dorsally and over 80% of females green dorsally, but a small proportion of females were brown or red-brown.

Both male and female C. producta were normally brown but 9 - 10% of each sex were green. In addition the brown forms varied considerably in shade and in the extent of white striping along the costal margin of the tegmen. These minor variations were not recorded. (See plate photo of grasshoppers).

TABLE 15.

SPATHOSTERNUM PYGMAEUM					CORYPHOCAEMA PRODUCTA			
BROWN	GREEN	BROWN	RED-BROWN	GREEN	BROWN	GREEN	BROWN	GREEN
203	0	9	11	109	427	45	207	20
100	0	7	8.5	84.5	90.5	95	91.2	8.8

APPENDIX 2

Species	Mean weight	S.D.	Mean body length	S.D.	Mean hind femur cm.	S.D.
Coryphacama producta	0.09125 0.1734	0.00364 0.02559	16.56 20.05	0.8271 1.729	10.53 12.73	0.6073 0.2990
Corydana agonmena	0.0639 0.1547	0.006105 0.01707	13.03 17.21	0.8368 0.9605	7.78 9.93	0.8684 0.3162
Spathostemum pygmaeum	0.0747 0.1856	0.008042 0.02716	15.84 21.00	0.6325 1.010	9.26 12.10	1.487 0.5375
C. spissus	0.9724	0.05051	34.86	0.4472	19.80	0.3162
E. plorans	0.3513 0.8735	0.03742 0.1195	23.00 31.93	1.113 1.683	14.55 19.70	0.6506 0.7637
C. compta	0.0951 0.1850	0.03194 0.01659	16.09 19.72	1.006 1.456	11.30 12.84	0.5056 0.6325
Acrida turrita	0.1846 0.8702	0.02581 0.1198	28.2 46.19	1.826 0.8164	23.8 37.38	0.9399 0.4472
Oedaleus nigeriensis	0.2948		24.80		14.80	
C. melanostictus	0.2108 0.4908	0.003162 0.04124	21.43 26.38	1.204 4.666	11.77 15.18	0.5478 0.8164
Attractomorpha aberrass	0.1309 0.3150		19.75 27.0		11.85 15.2	
Epistaurus succineus	0.1018 0.2051	0.025	14.8 18.48	0.3874	9.45 11.8	0.2738
Podula ancisa	0.2100 0.4438		21.0 28.0		10.0 15.0	
Morphacris fasciata	0.3038		23.6		15.2	
Trilophidia centrabata	0.091		15.8		8.5	
Heteropterna theracica	0.4047					

APPENDIX 3

Species	Mean wing length	S.D.	Mean prono-tum c m	S.D.	Mean Head cm.	S.D.	Antenae segments (a) mean (b) range	
Coryphacama producta	14.48	0.6767	2.92	0.2026	2.845	0.1433	24	23 - 27
	17.12	0.9290	3.715	0.1701	3.26	0.100	24	21 - 26
Corydana agomena	2.60	0.3066	3.00	0.200	2.32	0.1871	20	19 - 21
	3.05	0.3300	3.86	0.08145	3.04	0.2199	20	19 - 21
Spathostemun pygmaeum	10.69	0.6831	2.94	0.1633			21	20 - 22
	12.89	1.000	3.88	0.2646			22	21 - 23
C. spissus	31.03	0.200	7.97	0.1871	3.56	0.200	24	22 - 25
E. plorans	19.12	0.1036	4.65	0.200			25	23 - 26
	24.00	0.1807	6.14	0.3273	4.0		25	23 - 28
C. compta	15.27	0.8233	2.94	0.1764	2.3		22	20 - 24
	17.98	1.035	3.58	0.1124	2.6		22	21 - 23
Acrida turrita	32.4	1.770	5.7	0.1527	9.5	0.2683	17	17
	56.4	3.316	9.58	0.100	13.75	0.3162	17	16 - 18
Oedaleus nigeriensis	25.2		4.6		3.5		25	25
C.melanostictus	16.67	0.7416	4.367	0.1225	2.53	0.2237	24	23 - 24
	22.18	1.265	5.23	0.4933	3.05	0.2519	24	23 - 24
Attractomorpha aberrasis	16.75		4.25				14	14
	23.0		6.00				14	14
Epistaurus succineus	10.75		3.6		1.7		21	21
	13.12	0.8368	4.4	0.6893	1.8		22	21 - 23
			4.0		3.2		18	18
Podula ancisa	4.4		5.0		3.9		23	23
	4.5							
Morphacris fasciata	25.7		5.2		2.7		23	23
Trilophidia contrabata	16.1							
Heteropterna theracica								

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THE MYXOMYCETE PROJECT

by

R. McHugh

THE MYXOMYCETE PROJECT

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The 1962 Imperial College Botanical Expedition to Northern Nigeria brought back some myxomycetes in their collection. Myxomycetes or Mycetozoa are a group of strange organisms which appear to be intermediate between plants and animals. In the life history there is a plantlike stage, often looking like a small fungus. This produces spores, which in damp conditions give rise to the animal stage or plasmodium. This is an irregular piece of protoplasm: it is frequently a viscous sheet about an inch across, but the size range is very considerable. It creeps slowly in or on rotting vegetable material, feeding like an amoeba on bacteria, fungi, etc, and eventually develops again into the plant-like stage.

In Nigeria I collected the plant-like stages of myxomycetes: these are quite easily stored and preserved, unlike the plasmodia, which are very delicate. Most of my material was found on dead wood, usually wood which was rotting on the forest floor. By rolling over logs and picking up bits of bark and twig a large number of small fungoid growths were uncovered. Having had some experience of this work in Britain I considered myself competant to decide which of them were myxomycetes, but in the tropics there are an unfortunately large number of plants (especially fungi imperfecti) which look very similar to myxomycetes, and some of these were also inadvertantly collected, so that at length I found myself with fewer myxomycete species than I had expected.

Most of my specimens are sporangia: masses of spores, usually enclosed in a skin and supported on a stalk. The height varies from about a millimetre to about an inch. Some of them are masses of fused and stalkless sporangia: plasmodiocarps and aethalia: irregular blobs containing spores and the remains of sporangial walls. As they are rather easily damaged, I would cut away the material on which they were growing until there was a small piece. This was then pinned to the cork bottom of a box which I carried, so that nothing touched the myxomycete. When I brought the box indoors I dried the specimens in a cool oven and then repinned them in large corklined boxes of the type used for insect collections (borrowed from the British Museum : Natural History). These were then used to transport them back to England.

Our first myxomycete was Physarum pusillum (Berk. & Rav.) G. Lister, Mr. Dolling found 4 greyish-white stalked sporangia on a tree stump at the side of the road from Lagos to Ibadan, when the mammy wagon taking us from the airport to the university broke down. Of these 1 survived, and is now on a slide in my possession.

In the period 19-23 July I collected myxomycetes in the biological garden at the University of Ife. This is a section of mature secondary forest left untouched during the establishment of the university campus. Subsequently paths were made, trees labelled where possible, and some interesting African plants introduced. One third of the area is an inviolate plot, a wildlife sanctuary. My fundamental impression of the myxomycete population was obtained in

the biological garden: I saw here the commonest species. Lycogala epidendrum (L.) Fr. is among the most conspicuous common British species; it was also common here. It forms striking pink blobs about ½inch across, especially on the tops of lying logs. The material collected by the 1962 expedition was peculiar in having a darker colour, and warts on the surface of the aethalia, but the aethalia I found were just like British ones. I was familiar also with the species Ceratiomyxa fructulosa Macbr. and Arcyria denudata (L) Wettst. which were very common on damp wood of all sizes. The former is a mass of white feathery tufts; the latter is an extremely variable form having stalked sporangia varying from pale pink to dark brown. The dark brown form resembles the genus Stemonitis and I collected it separately, assuming it to be this. The dark colour is due to weathering. One of the pink clusters, however, turned out to be the recently described species Arcyria anglica Ing, and is a new record for Africa. Probably the most abundant species was Hemitrichia stipitata (Massee) Macbr. This has buff sporangia of a few millimetres diameter and is generally seen when branches on the ground are turned over. H. serpula Rost. also occurs and is the most beautiful myxomycete that I found. It has a gleaming eggyellow plasmodium which turns into a plasmodiocarp, an orange lacework of thick streaks standing out against the dark wood. I also obtained Perichaena depressa Libert, which has dull purplish plasmodiocarps, and an enormous cluster of the long-stalked orange sporangia of Physarum viride var aurantium Lister in a very rotten log: the wood was almost liquid.

Apart from the paper dealing with the 1962 myxomycetes, Myxomycetes from Nigeria by B. Ing, Trans.Brit.mycol.Soc. 47(1), 49-45 (1964), the only published account of Nigerian species is by Farquarson & Lister (1916). This describes 44 species and 3 varieties, collected by Farquarson, who worked for some years at Moor Plantation, Ibadan. I made several visits to Moor Plantation and looked at Farquarson's copy of Lister's Mycetozoa, with his notes on Nigerian species. The mycologist A.G. Bailey had been at Moor Plantation until June '66, and had left some specimens in the herbarium, presumably found in the grounds. Portions of these myxomycetes were kindly given to me by Miss E. Page, and included the following:

Arcyria denudata (L.) Wettst.

Fuligo septica Gmelin. This species has enormous plasmodia: some have been reported to exceed 1 foot across. The vegetative stage is a crusty aethalium: those from Moor Plantation are a couple of inches long, and of two varieties, greyish (var. septica) and yellowish (var. candida).

Diachea leucopodia Rost. All the sporangia available are in dense colonies on grass blades onto which the plasmodia flowed to fructify. They are ovoid black sporangia on short thick stalks very densely encrusted with lime, which also spreads over the grass. I was told that it was pretty common on the Plantation.

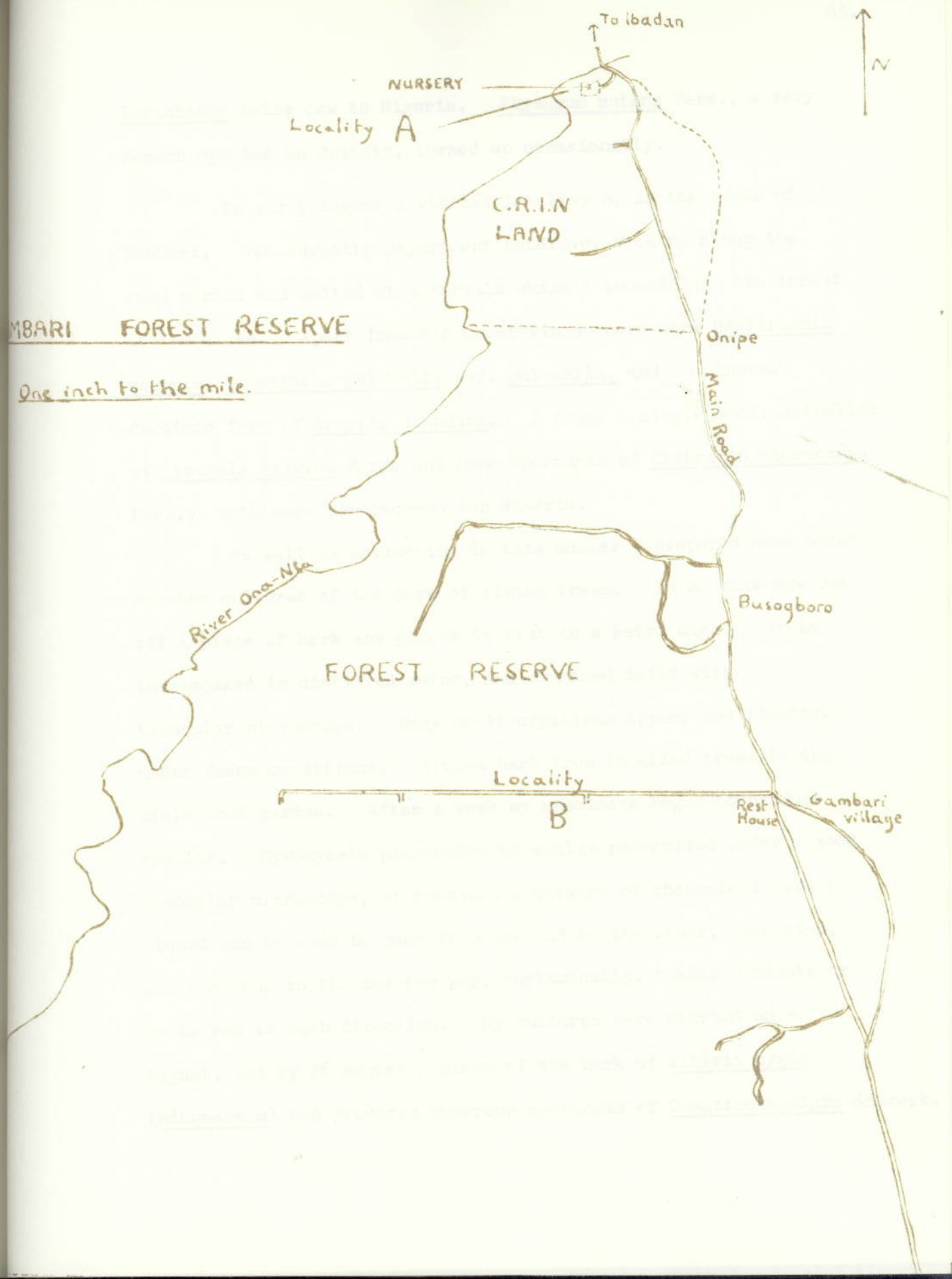
Physarum pezizoidium Pav. & Lag. has saucer-like sporangia on spindly stalks.

Stemonitis splendens Rost., a species with long tapering dark brown sporangia.

S. flavogenita Jahn., a smaller, paler Stemonitis: not unusual in Britain but new to Nigeria.

On looking at some old logs on Moor Plantation on 1 August I found Arcyria denudata, A. incarnata Pers. (a very similar and common species), S. splendens, Physarum viride var. aurantium and also var. viride.

Later on I did some work in the Gambari Forest Reserve, about 15 miles south of Ibadan. The Provincial Forest Officer, Mr. Ross Ibbotson, was very helpful and arranged for a native guide, who carried my specimen box and saw that I didn't get lost in the bush. At the end of July I collected in the high forest around the nursery in the north of the reserve (locality A on the map) and also on some of the adjacent C.R.I.N. land (Cocoa Research Institute of Nigeria). As in the biological garden, Hemitrichia stipitata, Ceratiomyxa fructulosa, and Arcyria denudata were very common. A massive Cottonwood trunk lying in a clearing had on it great patches of the last named species, which also grew on the bracket fungi sprouting from it. Arcyria incarnata, and the pale A. cinerea (Bull.) Pers. var. cinerea were also abundant. I found plenty of Stemonitis, the species being S. splendens, S. fusca Roth. and S. axifera Macbr. There were also Physarum cinereum Lister, P. stellatum, Lamproderma arcyrionema Rost., Comatricha pulchella var. gracilis Lister and Perichaena chrysosperma Lister, the


To Ibadan
N
NURSERY
Locality A
C.R.I.N
LAND
MBARI FOREST RESERVE
One inch to the mile.
Onipe
Main Road
River Ona-Nla
Busogboro
FOREST RESERVE
Locality
B
Rest House
Gambari village

Perichaena being new to Nigeria. Physarum nutans Pers., a very common species in Britain, turned up occasionally.

In early August I visited locality B, in the south of Gambari. The Forestry Department Landrover took me along the road marked and waited at intervals while I looked into the forest at the sides. Apart from the usual finds there were Hemitrichia serpula, Comatricha pulchella var. pulchella, and an abnormal digitate form of Arcyria denudata. I found a single small aethalium of Lycogala exiguum Morg. and some sporangia of Cribraria microcarpa Pers.; both were new records for Nigeria.

As well as collecting in this manner I prepared some moist chamber cultures of the bark of living trees. To do this one cut off a piece of bark and places it flat in a Petri dish. It is then soaked in distilled water, and examined daily with a binocular microscope. Many small organisms appear and flourish under these conditions. I used bark from labelled trees in the biological garden. After a week my specimens began to produce results. Myxomycete plasmodium is easily recognised under a good binocular microscope; it contains a network of channels in which liquid can be seen to pass from one end to the other, then stop, and then run in the reverse way, rhythmically, taking a minute or so to run in each direction. My cultures were started on 4 August, and by 26 August a piece of the bark of Albizia zygia (Mimosaceae) had produced numerous sporangia of Comatricha nigra Schroet.

This is the commonest British myxomycete, consisting of a tiny sphere on a tall thin stalk, like a beadheaded pin. In the British Isles it is very easily found under twigs in woodland. As far as we know this is new to West Africa. Physarum nutans grew on a culture of Daniella ogea (Caesalpiniaceae). The most productive preparation was a couple of square inches of Cola acuminata bark: on 15 August I removed from this some minute glittering sporangia - Cribraria violacea Rex, which was new to Nigeria. By 28 August it had produced a plasmodiocarp of Perichaena chrysosperma but as undeveloped plasmodium was still on it I dried it out and brought it home. At the end of September it was recultured and on 4 October were seen on it the strange banana shaped plasmodiocarps of the rare Licea biforis Morgan. This species is new to Africa.

While in Ibadan I visited the Forestry Research Department. Teak is an important economic tree, Gambari being partly a teak plantation, and the mycologist at Forestry Research had once made some moist chamber preparations of teak from Gambari. One of these had produced a myxomycete on 29 September 1965, and I took some of the sporangia. They were Physarella oblonga forma alba Morg. The form has not previously been recorded from Africa, or many other places for that matter.

All this was giving me an impression of the myxomycete population of southern Nigerial rainforest, compared to that of Britain, where different species are dominant, e.g. Comatricha nigra, Physarum nutans, and Trichia varia Pers. (Trichia species are almost

unknown from the tropics). From 18 to 21 August I was at Shaganu field station, where I saw species of the Derived Savannah. There are firstly fewer individuals here: the aridity means that unprotected plasmodium would not survive for long, and the ground vegetation is burned annually, so that only fireproof trees survive. Close to the river was a bare stone slope running along beside it, with a line of trees at the bottom. On the stone, beneath the trees, were some little piles of twigs and leaves, in which myxomycetes grew. The second thing about savannah myxomycetes is that the commonest ones are very small sporangial forms. In the habitat described I found Cribraria violacea, Cribraria intricata Schrad. (new to West Africa), Comatricha pulchella var. gracilis and Comatricha nigra, all of which are small. Also present were Physarum rigidum G.Lister and Arcyria cinerea, but neither of the 2 common pink Arcyrias of the South, nor Hemitrichia stipitata, were seen. The 1962 expedition, which worked on the Jos Plateau, found both the Arcyrias and the Hemitrichia, but not the other important rainforest species Ceratiomyxa fructulosa. In a swampy overgrown region near to the river I found a single small colony of Ceratiomyxa, but I think it is probably most unusual so far North. All these species grew near to the Niger. The only myxomycete which I found right out in the open was Stemonitis pallida Wingate.

The identification of my material was carried out by Mr. Bruce Ing in September 1966.

There were some incidental finds. While turning pieces of wood in the biological garden I had found a nymph of Ricinoides sp. This is very exciting; the animal belongs to the Ricinuloidea, a very rare and obscure order of Arachnida. The various fungi which I had picked up with my myxomycetes were submitted to the Commonwealth Mycological Institute, who identified as many as possible: University of Ife biological garden: Sporidesmium uvariicola M.B. Ellis, Stilbum sp., Podosporium sp., an item described by Dr. Ellis as "possibly a new genus of hyphomycetes; I know of nothing like it", and Nodulisporium gregarium (Berk & Curt) Moor Plantation, coll. A.G. Bailey: Thyronectria pseudotrichia (Schw.)Seeler

Ogbomasho, W.Nigeria: Stilbella proliferans F.L. Stevens

Oyo, W.Nigeria: Botryodiplodia theobromae Pat.

Gambari Forest Reserve, locality A: Nectria dealbata Berk & Br., Rhizoctonia sp., and Botryodiplodia theobromae Pat. Also Geniculosporium sp.

Gambari, locality A, also produced a basidiomycete of the genus Physalacria, probably P.decaryi (identified at Kew Gardens)

Gambari Forest Reserve, locality B: Thyronectria pseudotrichia (Schw.) Seeler, and Sporidesmium parvum (Hughes) M.B. Ellis.

Grounds of Forestry Research Department, Ibadan: Nectria dealbata Berk. & Br. d

Shaganu: Periconia narsapurensis Subramanian, and in the swampy area: Nectria dealbata Berk. & Br., Stilbella proliferans

THE PARASITOLOGY PROJECT

by

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DESCRIPTION OF MAXBRAUNIUM SP. (one of the digenes found in the stomach of the Nigerian bats) AND A DISCUSSION ON THE POSSIBILITY OF IT BEING A NEW SPECIES; FOLLOWED BY SUGGESTED A ENDMENTS TO THE DEFINITION OF THE GENUS.

by

Irene L. Riding
Zoology III

INTRODUCTION

105 bats of 3 different species were caught, killed and examined for parasites. The bats were:

40	Rhinolophus landeri	(Phinolophidae)	"Horseshoe bats"
40	Hipposideros caffer	(H pposiderae)	"Old World Leaf-nosed Bats"
25	Tadarida pumila	(Molossidae)	"Mouse tailed bats"

Identification was very kindly confirmed by D. R. Rosevear of the British Museum (Natural History), author of "Bats of West Africa".

SOURCE OF MATERIAL

Two colonies of bats were selected, chiefly on the accessibility of their roosting places. One colony, Tadarida pumila, lived in the attic of an inhabited house on Moor Plantation, 5 miles south of Ibadan, Western Nigeria, and the other colony lived in a small cave at SHAGUNU, Northern Nigeria, approximately 300 miles due north of Lagos. Two species of bats from different families, Rhinolophus landeri and Hipposideros caffer, inhabited this cave to form a mixed population of approximately 500 bats.

COLLECTION OF MATERIAL

Apparatus

Mist Nets - 12M. x 2.4M., 36 mm. mesh, 2 ply, 4 shelf, 70 denier.

Poles - 12 feet long.

Thick gloves.

Torches

Hessian bags 2' x 1'

Face masks

The mist nets were stretched between vertical poles along flight paths previously observed as the bats left their roosts. At least two people were required at each net, one person to hold the torch and the others to free the animal immediately it was caught. If the bats were not released quickly they became irretrievably entangled, and they also damaged the nets by chewing holes. Face masks were worn because bats micturate on becoming airborne and infection may possibly be transmitted by inhaling their urine. The masks also gave protection against the unpleasant smell surrounding the sites of bat colonies.

The bats were taken back to the laboratory after each collection and were kept overnight in cages ready for examination the following day. Early attempts at catching the bats by climbing into attics during the day time proved unsuccessful because, contrary to popular opinion, these bats did not sleep soundly, and they scuttled away more quickly than they could be pursued.

WORKING FACILITIES

Mr. J. Phipps, Head of the Zoology Department of Ife University, very kindly arranged for the expedition to have the use of an air conditioned laboratory together with the necessary scientific equipment and chemicals. The University is at present situated near Ibadan and most of our work was done there. However, two visits were made to the Kainji Dam Research Station at Shaguna on the banks of the River Niger, where accommodation and laboratory facilities were also provided.

EXAMINATION OF MATERIAL

1. Blood smears were made from the living bats either by cutting the pinna of the ear, or by piercing a vein in the inter-femoral membrane or in the wing. Three thin blood smears were then made with this periphal blood and were fixed in methanol. One smear was stained with Giemsa and examined; the other two were stored for further investigation. Blood films from the ear were also made.

2. Bats were killed with an injection 0.1 ml. of "Expiral" (which contains a barbiturate) and they succumbed within 50 seconds. The following observations were made immediately in each dead bat in order to avoid migration of its parasites:-

(a) Each bat was weighed and various measurements were recorded, but the length of the forearm was found to be the most practical and least subjective measurement.

(b) The fur and membranes were examined for ectoparasites. Their location and number were recorded before fixation in formalin and storage in labelled bottles for later identification.

(c) Each bat was dissected to remove the gut which was then pinned out in an uncoiled position. The gut was measured and opened from oesophagus to rectum in order to look for parasites with a binocular dissecting microscope. The exact location of each parasite was recorded before removing it and shaking it in warm A.F.A. fixative. They were then stored in 70% ethenol until time was available for staining and mounting. Whenever it was possible, observations, drawings and measurements were made from the living material.

(d) For each bat, smears were made of the heart, lung, liver, pancreas, spleen, kidney and brain; the urinary and gall bladders were inspected. The smears were fixed with methanol and stained with Geimsa. A small piece of each organ was fixed in either Bouin's or Carnoy fixative eventually to be embedded in wax.

(e) A representative selection of the different species of bats were skinned and the pelts and skulls preserved so that identification could be confirmed.

Approximately 300 blood smears and organs and parasites of 114 bats have been brought back to Imperial College, but for the purpose of this report only one species has been dealt with thoroughly as yet.

DESCRIPTION OF SPECIMENS

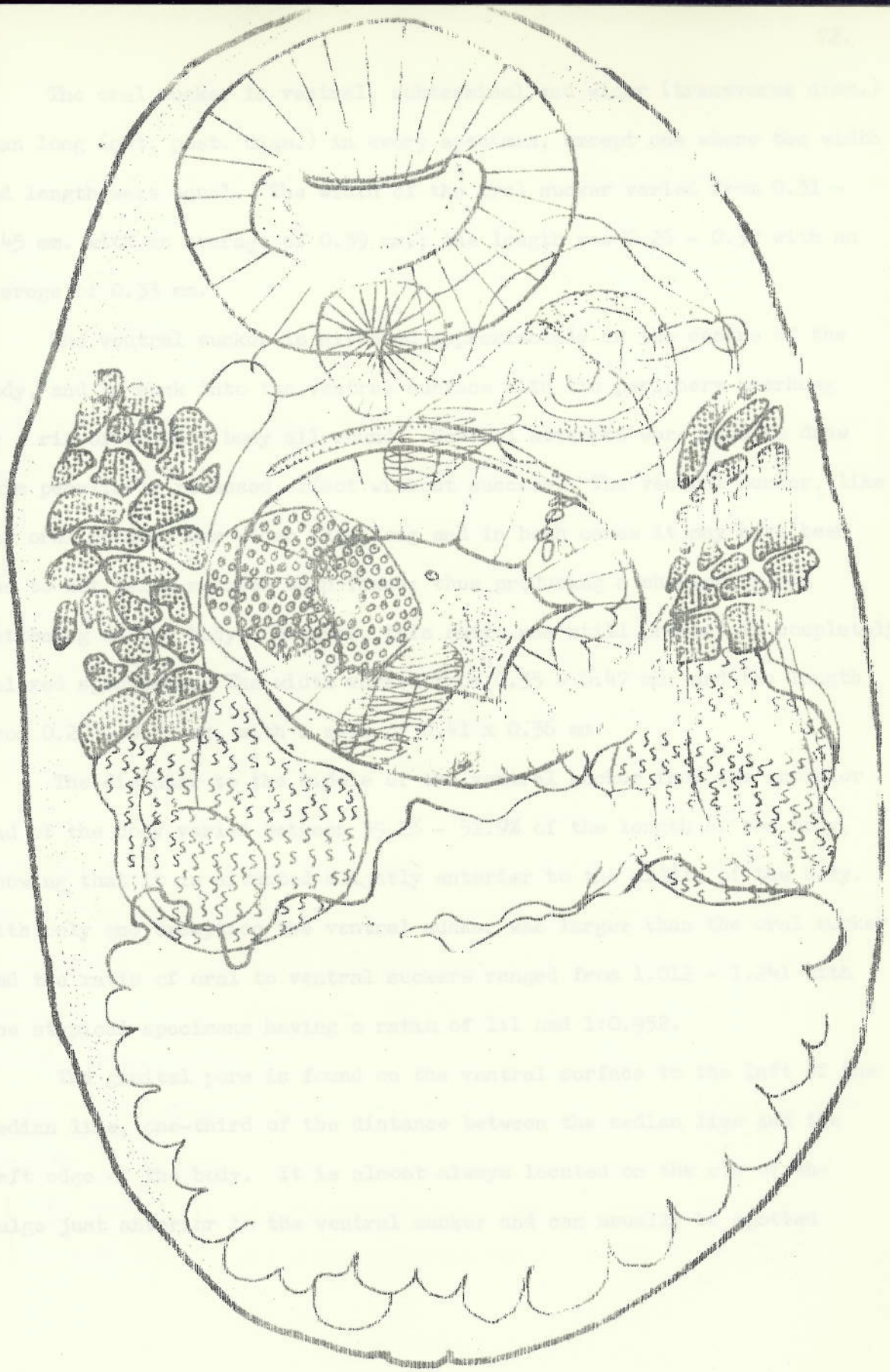
Order Plagiorchiida	Luhe 1901
Family Lecithodendriidae	Odhner 1911
Sub family Maxbrauniinae	Yamaguti 1958
Genus Maxbraunium	Caballero and Zerecero 1942

The largest and most abundant of the digenes that were found in Tadarida pumila occurred in the pyloric region of the stomach and 64% of the 25 bats were infested with a total of 103 specimens; an average of 4.12 per bat . This digene was strongly curved with a rounded dorsal surface and the anterior and posterior ends curled ventrally towards each other. They were very sluggish and firmly attached, leaving a deeply recessed scar in the lining of the stomach when removed, indicating that probably long periods were spent in one position.

The structure of these digenes (ref. Fig. 1) was particularly clear just prior to their dying, but most of the following data was collected from 18 out of 35 fixed, stained and cleared whole mounts and 4 that were serially sectioned.

EXTERNAL FEATURES

The length varies from 1.05 - 1.72 mm. with an average of 1.38 mm. and the specimen at 1.05 mm. was very atypical (ref. Table 11). The maximum width varies from 0.77 - 1.07 mm. and most often the broadest part occurs about 3/4 of the way down the body from the anterior end, but occasionally oval shaped specimens were found.



The oral sucker is ventral, subterminal and wider (transverse diam.) than long (ant. post. diam.) in every specimen, except one where the width and length were equal. The width of the oral sucker varied from 0.31 - 0.45 mm. with an average of 0.39 mm.; the length was 0.26 - 0.30 with an average of 0.33 mm.

The ventral sucker is situated approximately in the centre of the body, and is sunk into the ventral surface with its periphery overhung by a rim of bulging body all round. Several attempts were made to draw this peculiarly recessed effect without success. The ventral sucker, like the oral sucker, was wider than long and in both cases it may have been due to not being relaxed when fixed; thus producing a shortening and fattening of the body. However, this ratio was still present in completely relaxed specimens. The width varied from 0.35 - 0.47 mm. and the length from 0.29 - 0.41 mm. with a mean of 0.41 x 0.36 mm.

The distance to the middle of the ventral sucker from the anterior end of the body varied between 39.2% - 51.9% of the length of the body, showing that it is situated slightly anterior to the middle of the body. With only one exception the ventral sucker was larger than the oral sucker and the ratio of oral to ventral suckers ranged from 1.012 - 1.241 with the stypical specimens having a ratio of 1:1 and 1:0.952.

The genital pore is found on the ventral surface to the left of the median line, one-third of the distance between the median line and the left edge of the body. It is almost always located on the rim of the bulge just anterior to the ventral sucker and can usually be spotted

because of the prominent lips which surround it; the genital pore itself is a very narrow small slit (Fig. 1 and 2).

The excretory pore is terminal or slightly sub-terminal and ventral

It can occasionally be seen in whole mounts but because of its minute size it is found more easily in serial sections.

The opening of Laurer's Canal is on the dorsal surface, median and at such a level that it is obscured by the anterior edge of the acetebulum when whole mounts are viewed from the ventral surface. Like the excretory pore, it is more easily found in serial sections. (Actually the photograph shows Laurer's canal; the pore is present in subsequent sections but its position can be estimated from this Section).

INTEGUMENT

The ventral surface and the anterior half of the dorsal surface are covered with tiny spine-like scales 5-20μ long. Their shape, size and distribution varies according to their location on the body (Fig. 111).

There is an area completely devoid of scales on the dorsal surface, from the middle of the anterior edge of the ventral sucker broadening out to a triangular shape reaching the posterior lateral edges of the body. At the other extreme is the anterior dorso-ventral surface where spines are present in great abundance. On the ventral surface the spines are more curved and scale-like with broader bases; on the dorsal surface in front of the ventral sucker they are less curved and more needle-like and more sparsely distributed.

The cuticle is also differentiated around the body. Its thickness varies from 15μ on the posterio-dorsal surface to 6μ laterally.

The cuticle is underlain by the usual basement membrane and a layer of circular muscle bundles followed by longitudinal muscles and occasional oblique muscle bundles. These layers are considerably increased in the anterio-dorsal region and on the ventral surface near the ventral sucker, but only slightly developed in the posterio-dorsal region where little mobility is required.

THE GUT

The mouth surrounded by the oral sucker leads into a prepharynx and a pharynx followed by an oesophagus which leads into bifurcated unbranched caecae.

The Prepharynx is very short and could not be seen in whole mounts but is visible in sections. It is a thin-walled tube that permits a separation of the muscles of the oral sucker and the pharaynx and also facilitates the right angled bend between the mouth and the pharynx which is essential because the region immediately posterior to the pharynx is filled by the enormous cirrus complex.

The pharynx is relatively large and muscular having a width of 0.10 - 0.17 mm. with a mean of 0.13 mm. and a length 0.10 - 0.18 mm., mean 0.14 mm. It lies in the median line but is bent at right angles to the long axis with its oesophageal end pointing dorsally and its opening from the prepharynx facing the ventral surface which explains why this aperture is often clearly seen in the whole mounts.

The pharynx leads into a short oesophagus which forms a second right-angled bend and brings the gut parallel to the prepharynx but lying in opposite directions. The oesophagus bifurcates and continues

its cuticular lining for about 100μ when it abruptly ends and the large epitheliel cells characteristic of the rest of the Caecae occur. These cells stain darkly with Erlich's haemotoxylin and are frequently vacuolated, suggesting that intracellular digestion occurs. The two caecae do not branch, but often there are distenions, particularly at the posterior end, where the cells are long and narrow instead of short and fat but this is probably due to difference of a relaxed to an extended position, and not due to porphological or physiological differences. The caecae end close to the posterior end of the testes . . between 60-76% along the length of the body from the anterior end.

THE MALE REP. DUCTIVE SYSTEM

The testes are situated just posterior and laterial to the ventral sucker with the right one slightly in front of the left; the right testis lying 43% - 54% down the body from the anterior end and the left testis between 44% - 55%.

The right testis is also slightly bigger than the left with a size of 0.18 - 0.40 mm. x 0.15 - 0.32 mm. (mean 0.33 mm. x 0.22 mm.) while the left testis varies from 0.22 - 0.35 mm. x 0.13 - 0.30 mm. (mean 0.29 x 0.20 mm.). They are roughly symmetrical but their shape ranges from oval or spherical to pear shaped and irregular (Fig. 1)

The vasa deferentia are narrow faintly staining tubes which leave the testes along the anterior part of the median edge of each testis. They pass forwards lateral to the ventral sucker, dorsal to the vitelline ducts and ventral to the ovary following a winding path but not strongly looped or coiled. The left and right vas deferens only fuse at the point of entry into the internal seminal vesicle inside the cirrus pouch.

The cirrus pouch is one of the most noticeable features of this digene because of its large size and the deeply staining cells it contains. The transverse diameter is 0.31 - 0.46 mm. according to its orientation. Occasionally it lies in a dense ventral plane rather than the more usual left-right disposition (Fig. 1). The maximum length of the cirrus pouch in the anterior-posterior direction is 0.17 - 0.29 mm. and the mean of the two diameters length x width 0.38 mm. x 0.23 mm. Inside the pouch from its proximal to its distal ends (right to left viewed from ventral surface) are the seminal vesicle, the pars prospatica, the cirrus or ejaculatory tube, the metraterus and the genital atrium.

The sedimal vesticle is internal and 0.18 mm. - 0.24 mm. long, divided into two chambers by a sphincter muscle (Fig. 5 shows the proximal half of the seminal vesicle and the sphincter muscle). It is unusual to find both portions equally filled with sperm; normally one is full and the other one empty giving the appearance of a muscular tube rather than a vesicle, and the two together resemble a retort in shape. The proximal chamber of the seminal vesicle lies in a dorso-ventral plain but the distal vesicle twists round and lies at right angles to it, transversely across the body, and leads into the pars prostatica.

The pars prostatica lumen often contains sperm and is lined with large columnar shaped epithelial cells which stain well with Erlich's haemotoxylin. It is 0.11 - 0.13 mm. long and 0.07 - 0.13 mm. wide and is surrounded by large unicellular prostate glands which have long tapering necks that open into the lumen of the pars prostatica in between the epithilial cells. They are probably responsible for the granular

secretion observed in the lumen among the sperm and they are long enough to stretch back and surround the seminal vesicle and fill all the space inside the cirrus pouch in the proximal region.

The cirrus is a continuation of the pars prostatica but can be clearly distinguished from the latter region by the nature of its lining, the thickness of its muscle wall, the surrounding cells and the presence of spines. It is 0.25 - 0.27 mm. long and 0.04 - 0.10 mm. wide, transversely orientated except for its distal region which curves strongly towards the ventral surface towards the genital pore.

The wall of the cirrus is thick and muscular and the lumen is not lined with an epithelium; instead there is a lining of amorphous material that stains similarly to the cuticle round the body, although not so well, and is probably a mucoid substance. Projecting through this layer is a large mumber of spines which are particularly concentrated along the posterior side of the cirrus lumen, and range from 3 to 12μ in length and 2 to 7μ in width at the base. The general shape of these spectacular spines varies from small pyramid-like studs to long tapering and sharply pointed tacks. One specimen with a partially erected cirrus showed the spined region to be protruded and inflated like a round ball (unfortunately no time to draw - see whole mount "specimen 14").

The distal end of the cirrus has no spines and opens into the genital atrium which also receives the metraterm before opening to the exterior at the genital pore. The genital atrium is 0.07 - 0.13 mm.long and 0.03 - 0.06 mm. wide. (Many of the above measurements were taken from sections where it was impossible to get them from whole mounts.)

THE FEMALE REPRODUCTIVE SYSTEM

The ovary is situated dorsally just to the right of the median line at the level of the anterior half of the ventral sucker (Fig. 1) It is discrete, often oblique and roughly oval in shape, from 0.17 - 0.24 mm. x 0.13 - 0.26 mm. with a mean of 0.21 x 0.16 mm., and its anterior edge lies between 30% - 40% down the length of the body.

The oviduct arises from the inner side of the posterior edge of the ovary, medio-posterior to the lighter stained avicapt region. It coils at least once before being joined by Laurer's canal and the duct from the seminal receptacle, and lies dorsal to the right vitelline duct but ventral to the seminal receptacle.

The seminal receptacle is always present but is very variable in size and position, but is always somewhere inside the circumference of the ventral sucker and dorsal, and usually posterior-median to the ovary (Fig. 1). It is mostly oval in shape and its size is 0.10 - 0.25 mm. x 0.05 - 0.22 mm. (probably according to the amount of sperm it is storing at the time of fixation) with a mean of 0.17 x 0.12 mm.

Laurer's canal is a narrow tube but clearly defined by its muscular walls and it coils several times in the middle of its length. It is very unlikely that it could accommodate the massive cirrus although sperm was present in proximal part but these may have entered here. The canal passes round the dorsal side of the ovary (and the seminal receptacle when the latter occurs in an anterior position) and then takes a ventral course to meet the oviduct which is median.

After fusion of Laurer's canal and the duct from the seminal receptacle to the oviduct, it widens into a region where both sperm and oocytes were present and thus could probably be called the fertilisation chamber. This is jointed by the yolk reservoir, which is often clearly defined in whole mounts and ventro-median. It is formed by the fusion of the left and right vitelline ducts which pass anterior to the testes traversing the ventral sucker obliquely leaving the vitellaria. The vitellaria are lateral and ventral, composed of 15 - 30 follicles arranged in elongate masses between the posterior edge of the oral sucker and the anterior edge of the testes.

After the darkly stained vitelline cells enter the oviduct, the presence of the large uninucleate cells of the mehlis gland indicate the region of the ootype It is located in the middle of the body equidistant from the anterior, posterior, dorsel or ventral edges, but it is usually difficult to find in whole mounts. Different stages of egg formation were observed in the sections and three to eight vitelline cells were enclosed with each oocyte. The proximal part of the uterus arises from the ootype, ventral to the yolk reservoir, and descends to the posterior part of the body on the left side. It undergoes numerous convolutions in spreading to the right side and occupies the whole of the posterior one-third of the body before the distal part begins to ascend. It crosses obliquely from the right to the left side in the region of the posterior edge of the ventral sucker, ventral to its own proximal part but soon becoming dorsal as it passes forwards to the region of the cirrus pouch. During their passage along this route the eggs change

in colour from pale yellow to dark brown, characteristic of a tanning process, and the shell gets thicker. The shape is remarkably like that of a hen's egg. It is operculate and has a mean size of 0.016 x 0.027 mm. with a range of 0.023 mm. - 0.030 mm.: x 0.013 - 0.017 mm.

The uterus develops thicker muscular walls (0.04 mm. diameter) just posterior and lateral to the cirrus pouch and now the metraterm descends from the dorsal to the ventral side following a course round the left side of the cirrus. It enters the genital atrium ventral to the cirrus.

EXCR TORY SYSTEM

No flame cells were observed but there are numerous tiny, faintly staining excretory tubules scattered throughout the parenchyma and particularly in the anterior region.
to right testis). They appear to drain into the two anterior horns of the large excretory vesicle which reach as far forward as the cirrus pouch. The excretory vesicle is very thin walled but lined with a flattened epithelium which bulges into the lumen at varying intervals where ever nuclei occur. The vesicle is either V shaped or Y shaped with a very short stalk just prior to the excretory pore. the posterior end of a series of transverse sections but as the body curves at its extremities this section is probably oblique and thus gives an insight into what the shape of the excretory vesicle might be. Fig. 5 is a drawing of a ventral longitudinal section and illustrates the two limbs of the excretory vesicle near the posterior end. Without further experience of "V's" and "Y's" it is difficult to know how short the stalk is permitted to be to qualify as a Y; without this knowledge

the excretory vesicle looks V shaped. The distal end of the excretory vesicle is surrounded by elongated columnar cells and the excretory pore is lined with cuticle.

NERVOUS SYSTEM

Nothing of taxonomic significance was observed in the nervous sytem. Large neurones were scattered throughout the parenchyma with concentrations around the region of the prepharynx.

A NEW SPECIES OF THE GENUS MAXBRAUNIUM?

It is obvious that the specimens described above belong to the family Lecithodendridae.

Tracking down the genus was not so easy because of the close resemblance of these specimens to Limatulum, Parabascus, Cephalotrema and other closely related genera. For example, Cephalotrema, Baer 1943, is diagnosed as follows:-

Pleurogenetines of small size.

Suckers unequal, well developed.

Cuticle armed with spines.

Intestinal caecae do not reach the posterior end.

Testicles symmetrical, behind ventral sucker.

Ovary pretesticular, level with ventral sucker

Vitelline glands little developed, forming two racemes laterally, between the two suckers.

Laurer's canal and seminal receptacle present.

Cirrus pouch large enclosing a double internal seminal vesicle as well as a pars prostatic.

Uterus folded on itself in the posterior part.

Genital atrium ventral, on left, at the level of the oral sucker.

Excretory vesicle "V" shaped.

Adults occur im mammals.

One can see that the specimens in question fit this description perfectly. It was only after closely studying the description and drawings of the type-species C. minutum that minor differences were noticed - such as the more anterior position of the ovary, the genital pore being more posterior and no mention of cirrus spines (although these could have been overlooked as none of these digenes were sectioned. Also this genus occurs in rodents, not bats.

However, once the genus Maxbraunium, Caballero et Zerecero 1942, was considered, the correct position was realised. These two authors established the genus after studying three specimens from the small intestines of Mexican bats, and concluded they were the same as a digene (one specimen only) found in a Brazilian bat and which had been described by Max G. Ch. C. Braun in 1900 as Distomum tubiporum, Braun 1900. The genus Distomum contained a wide variety of distantly related species and so a new genus was created by Caballero and Zerecero in 1942, with the following definition:-

MAXBRAUNIUM n. gen.

"Oval body, thick and spiny cuticle, sub-terminal oral-ventral sucker. Spherical and voluminous acetabulum limited to anterior half of

the body; muscular pharynx; oesophagus absent; intestinal caecae beginning immediately after the pharynx and continuing a little beyond the testis; cirrus bursa largely developed, transversely disposed between the pharynx and the acetabulum; seminal vesicle twist shaped genital pore sub median and post pharyngeal on the left side; symmetrical ovoid and post-acetabular testis; ovoid ovary on the right side in the same level as the acetabulum and partially covered by it. Seminal receptaculum clearly defined and placed behind the acetabulum either on the right or the left side. Mehlis' gland, Laurer's canal and ootype present behind the acetabulum and on the left side. Uterus, from the posterior part of testes to posterior end of body, in the extra-caecal, caecal and intercaecal regions of the posterior part of the body. Ascending branch of uterus, left ventral, crossing over between the internal edge of the left testis and the external left edges of the seminal receptacle and the acetabulum. Vitelline glands in the lateral regions of the body from the anterior edge of the cirrus bursa up to the half of the testes. Oblique vitelline ducts joining in the posterior right or left edges of the acetabulum. Eggs ovoid and dark yellow with operculum. Excretory apparatus V-shaped."

Type species Maxbraunium tubiporum Braun 1900 N. comb.

Distomum tubiporum	Braun 1900
Distoma tubiporum	Styles and Hassal 1908
Distomum tubiporum	Viana 1924
Limatulum tubiporum	Northup 1928
Distomum tubiporum	Styles and Nolan 1931

Yamaguti (1958) considered the genus Maxbraunium to be sufficiently different from other genera as to merit the status of a sub family and named it Maxbrauniinae. Until three years ago there was only one species (and one genus) in this sub family when Rhode described a new species (M. baeri Rhode 1964) after finding five mature and three immature specimens in the intestines of Malayan bats.

And now there is the question "To which of the two species do the Nigerian digenes belong?" The three digenes (Mexican, Malayan and Nigerian) will be compared and contrasted wherever there is sufficient data; mamy of the measurements of M. tubiporum and M. baeri have been taken from the camera lucida drawings included with their original descriptions

because in some cases only maximum and minimum measurements were given instead of data from each specimen being presented separately.

It is perhaps as well to state at the beginning of this discussion that Mr. S. Prudho, Helminth taxonomist at the British Museum (Natural History), has recently (27/5/67) looked at the specimens and has no doubt whatsoever that the Nigerian Maxbraunium is a new species. The single feature which distinguishes it from the two existing species is its shorter gut caecae. The Nigerian specimens have gut caecae which terminate at the level of the posterior end of the testes while the other two species have caecae which end approximately midway between

the posterior end of the testes and the posterior end of the body. The % length down the body of the gut caecae is between 61% and 69% (except for the atypical small specimen No. 5 with 76%) while in M. tubiporum it is 78% to 85% and M. baeri 79% to 90.2%. .. The shorter gut is a constant feature of all the Nigerian specimens, not just in a few, and therefore is unlikely to be an artifact because this would necessitate an uneven concentration of the dorsal and ventral surfaces during fixation, to change the relative position of the caecae to the testes.

With the exception of this characteristic there is very little to separate the Nigerian specimens from the Malayan and Mexican ones. The distribution of cuticular spines is evenly all over in M. tubiporum, and in M. baeri they are absent on the posterior dorsal surface except for a lateral margin on the side of the genital atrium (left) which bears spines; in the Nigerian specimens they are absent from the posterior dorsal surface and also absent from the lateral margin on the left side.

The cirrus of M. Tubiporum is not spined (or else Caballero and Zerecero failed to see the spines); M. baeri cirrus has "scales" but the large "studs"/"tacks" of the Nigerian specimens could never be described as scales. However in this case Rhodes poor knowledge of English might be the cause of this anomaly. The excretory pore in M. tubiporium is posterior and dorsal; in M. baeri it is terminal but in the Nigerian specimens it is subterminal and ventral.

The fact that there are only three specimens of M. tubiporum and five (mature) specimens of M. baeri makes it impossible to compare

them properly with the Nigerian specimens, but a brief survey will be attempted. The overall impression gained is that the data from the 18 of Nigerian specimens so far measured, spreads between the figures for M. tubiporum at the one side and M. baeri at the other and that probably they are all one species. An example is the ratio of ventral sucker to body length. The ventral sucker is larger in M. baeri and smaller in M. tubiporum compared to the Nigerian specimens and when isolated they appear quite distinct species but on addition of the data from the new specimens, it can be seen that perhaps only one species is involved.

The ratio between the oral and ventral suckers in M. tubiporum is described as 1:1 whereas in M. baeri the ventral sucker is the larger of the two. Graph IV shows that in fact there is a complete inter-gradation of these ratios when the Nigerian specimens are considered, because they have ratios ranging from 0.95 (oral sucker larger than ventral) to 1.24 (vice versa) which cuts across the difference between M.tubiporum (1.031) and M. baeri (1.137 - 1.323).

One must be quite clear about the differences between the two species put forward by Rhode in 1964 when he established the second species M. baeri. His new species was based on just three differences,

which were:-

	M. baeri (Rhode 1964)	*M. tubiporum* (Caballero 1942)
1.	Ventral sucker larger than oral.	Suckers same size
2.	Suckers relatively larger	
3.	Ovary more anterior	

It has now been shown that the first two differences are useless as far as a key to species is concerned, but the third involved the position of the ovary which has not yet been considered. In *M. tubiporum* the ovary lies between 42% - 43% down the body from its anterior end and from the information published about *M. baeri* it is difficult to understand why this character was chosen, because although one specimen is located at 31%, another one is further back than *M. tubiporum*, lying at 46%. It is interesting to see that once again the Nigerian species cuts across the range of positions (with 30% - 43%) except for the *M. baeri* specimen at 46% which is supposed to have an anterior ovary.

Many other characters have been compared such as the relative position of the right and left testes and the genital pore; the relative sizes of organs such as the cirrus pouch, pharynx, ovary, testes and seminal receptacle (absent in *M. baeri*) as well as a comparison of the lengths and widths of the digenes, but nothing of significance was discovered and therefore the graphs have not been included except for the few representative, selected examples already mentioned. In all cases a gradation of characters was found. Neither was anything to be learned by looking at the hosts because each of the four bats belongs

to a different genus and even to different families.

Thus one might conclude that a revision of the genus Maxbraunium is called for on the grounds that although Rhode was justified in creating a second species from the measurements of the few Malayan specimens that he had found the discovery of more specimens has shown a wide range for each character and the two species can no longer be distinguished. Thus M. baeri would become M. tubiporum.

It would have been useful to analyse this data statistically. The ratio between any two organs could be found from 18 or more of the Nigerian specimens and then a Chi squared (X_2) test done for the ratio of the same organs in the specimens of M. baeri and M. tubiporum; the results would show whether or not the ratios are within those that might be expected for a Nigerian specimen. If so then it is most likely that the specimens belong to the same species. It has been suggested that a multivariables analysis would be useful but this test requires a very good statistician.

However, Prudhoe believes that greater familiarity with the family Lecithodendriidae would lead to the realisation that characters shared by specimens are not important in determining species; where just one consistent difference occurs (in this case length of gut caecae) then a different species is being observed.

Unfortunately I feel that more information about the two existing species is needed before one can decide to create a new one. The type specimens for each species are unavailable but as Rhodes is coming back to Germany this month, he might be able to supply more data about M. baeri.

It seems to me that there are more differences between his solitary specimen (Holotype) from Rhinolophus sp. and the ones he got from Tylonycteris sp. than there are between these and M. tubiporum.

I also think that his drawing of the holotype was influenced by his original tentative identification of it as belonging to the genus Cephalotrema (see Rhode 1963) but this is irrelevant here except to explain the shape of the cirrus pouch. This drawing (Fig. 11 top left) puzzled me for a long time until I realised it was a "V" shaped Cephalotrema-type cirrus pouch interpretation of what must have been a Maxbraunium pouch in a ventral orientation. This is the sort of difficulty that is bound to arise so long as taxonomy remains subjective; but to return from this digression - if any one person were able to examine all the described specimens from Mexico, Brazil, Malaya and Nigeria one might stand a better chance of deciding whether to "lump or split" the genus Maxbraunium.

In either case it is obvious that the generic definition needs revising to include the characters of M. baeri and the Nigerian specimens. (See diagnosis listed above). One of the most obvious features not included in the description of the Maxbraunium genus is the heavily armed cirrus which is characteristic of the latter specimens. It may well be that M. tubiporum cirrus really is unarmed as reported by Caballero and Zerecero (1942) because it is difficult to believe that these two experienced workers could have overlooked them; unfortunately they used whole mounts and the spines only become really obvious in sections, unless one sees an overted or partially overted cirrus.

The seminal vesicle is defined as being "retort shape". This has been explained in the description of the Nigerian specimens and it would be more helpful to describe the seminal vesicle as bipartite because the shapes assumed by the two chambers is transient.

The seminal recaptaculum is not "clearly defined" except in a small minority of specimens and M. baeri has not had one observed at all; it may be absent of course o simply not visible due to the specimens being in a protandrous condition.

The cuticle is "thick and spiny" in the original definition but a naked region of the posterior half of the dorsal surface is common to M. baeri and the Nigerian specimens, while the assumption made is that the spines are evenly distributed all over in this genus.

The description of the gut also needs a slight modification because the caecae do not arise "immediately after the pharynx" because the two groups of recent specimens both have a short oesophagus. Also the anterior part of the bifurcation has much narrower walls than the rest of the caecae and the latter terminate between the posterior part of the testes and the posterior end of the uterus mass.

The amended definition of the genus Maxbraunium would read (alterations underlined):-

"Oval body; thick and spiny cuticle with or without a naked region on the posterior half of the dorsal surface; subterminal oral sucker; spherical and voluminous acetabulum limited to the anterior half of the body; prepharynx present but very small; small oesophagus present; gut caecae end between the posterioredge of the testes and the posterior edge of the body; cirrus pouch largely developed, transversely disposed between the pharynx and the ventral sucker or with a ventral orientation;

seminal vesicle bipartite; genital pore sub median and post pharyngeal on the left side; symmetrical, ovoid or slightly irregular testes; post-acetabular; ovoid ovary on the right side at the same level as the acetabulum and partially covered by it; seminal receptaculum present or absent, often poorly defined and placed behind the acetabulum either on the right or left ....."

(Rest of definition as Caballero and Zereceor 1942)

SUMMARY

One of the digenes found in the West African bat Tadarida pumila during the Imperial College Expedition to Nigeria: 1966, belongs to the genus Maxbraunium. It has been described and then compared with the other members of the genus which are M. tubiporum and M. baeri; the first from Mexico and the second from Malaya.

Evidence has been put forward to show that the Nigerian specimens may be regarded as a new species. Conversely it was argued that the two existing species of this genus can no longer be regarded as such because the Nigerian specimens show an intergradation of their properties thus M. baeri would become M. tubiporum.

In addition it has been shown that the definition of the genus Maxbraunium could usefully be amended.

Irene L. Riding.
June 1967.

(Further work has been done on this digene and it has now been established that it is a new species and is to be named Maxbraunium nigeriense. The paper describing this new species, together with a second new species found during the expedition, has been accepted by the Journal of Parasitoloty and will be published later this year. January, 1968)