

Hervy, J.-P., L. Ferrara, and F. Legros. 1985. Aedes (Diceromyia) furcifer (Edwards, 1913) et Aedes (Diceromyia) taylori Edwards, 1936: diagnose des larves de quatrième stade. Cah. O. R. S. T. O. M., ser. Entomol. Med. et Parasitol. 23: 17-24.

4TH STAGE LARVAE

translated from French by George C. Steyskal
Dec., 1985

INTRODUCTION

The epidemiological importance in West Africa of Aedes (Diceromyia) furcifer (Edwards, 1913) and A. (D.) taylori Edwards, 1936, induced Ferrara, Germain, and Hervy (1984) to present a key to these 2 species for determination of the adults, especially the ♀s which had been confused under the designation of "furcifer-taylori group." The present contribution is a logical continuation of that work, and deals with the 4th stage larvae of these 2 sympatric species and presents a viable diagnosis, which has so far been lacking.

p.17

1. MATERIAL, TECHNIQUES, AND METHODS.

p.18

1.1. Material. Dealing with larvae of A. furcifer and A. taylori collected in wooded localities in the area of Kédougou (eastern Senegal), this study was made on recently colonized individuals (through about 6 generations) from that area. Continual observation on the 2 groups has repeatedly shown them to be homogeneous and conspecific.

1.2. Techniques. Observations were made chiefly on 4th stage exuvia preserved in Amann's lactophenol. Each specimen was referred to the one species or the other on the basis of the adult that emerged from the exuvium without risk of error.

Examination of unmounted exuvia under a binocular microscope enabled us ~~to~~ first ~~to~~ to enumerate most of the characters. Specimens mounted on slides and coverglasses in a drop of polyvinyl alcohol and examined under a microscope allowed further study and correction of the first data.

Some observations and the illustrations, in a light chamber, were made on A. taylori with larvae preserved but not mounted in Amann's lactophenol.

1.3. Methods.

Quantitative observations - counting the number of branches of a seta or the number of spinules in a pecten - were done systematically in 27 anatomical positions

on the head, segment VIII, the siphon, and segment X.

We used the chetotactic nomenclature of Knight and Laffoon (1971); that of Edwards and Givens (1928, in Hopkins, 1952), commonly employed, in mentioned in parentheses.

The inventoried sites are as follows:

antennal setae: 1-A.

cephalic setae: 4-C (d), 5-C (C), 6-C (B), 7-C (A), 8-C (e), 9-C (f), 10-C, 11-C,
12-C, 13-C, 14-C, 15-C,

buccal setae: 6-MP, on palpifer,

setae of seg. VIII: 1-VIII, 2-VIII, 3-VIII, 4-VIII, 5-VIII,

setae of siphon: 1-S, 2-S,

setae of seg. X: 1-X, 2-X, 3-X, 4-X,

spinules of pectens: p. of seg. VIII, p. of siphon.

A 28th datum, the siphonal index, was obtained from unmounted exuvia.

More than 200 larvae of each species were analyzed. The precise number of specimens kept varied from 198 to 224 A. taylori, and from 195 to 213 A. furcifer, according to the character studied, because of elimination of exuvia that were partially damaged.

Each exuvium was routinely labeled as to species, sex, and serially numbered. The numerical value of the character established by counting was inscribed on the label.

Qualitative observations, form and thickness of the setae and pectinal spinules, were recorded not only on the characters recorded in the quantitative scheme, but also on characters of the thorax and abdominal segments I to VII, less frequently used in the diagnoses.

2. RESULTS.

2.1. Quantitative Observations. Taking account of the symmetry of the sockets of the setae and spins^e_A in culicid larvae, there are 27 pairs of chetotactic values and the one siphonal index taken for each exuvium in good condition. The mentum, not seen in an unmounted larva, was excluded from our considerations.

In the treatment of the data, each element of a pair is considered as an independent value after the comparisons of the frequencies of the pairs and the values have been established as having random combinations.

The first summation of the results has permitted us to ~~recognize/ say~~ ^{an absence of} significant differences in character values between the sexes; we have therefore combined the sexes in subsequent grouping of the data.

Table I presents for each species and for each character the following:

- extreme observed values,
- the arithmetic mean, and
- values which may be considered as specific.

The histograms of Fig. 2 show graphically for each species the distribution of the various character values. The following, with a constant value of 1, are not shown:

4-VIII, 2-S, and 3-S.

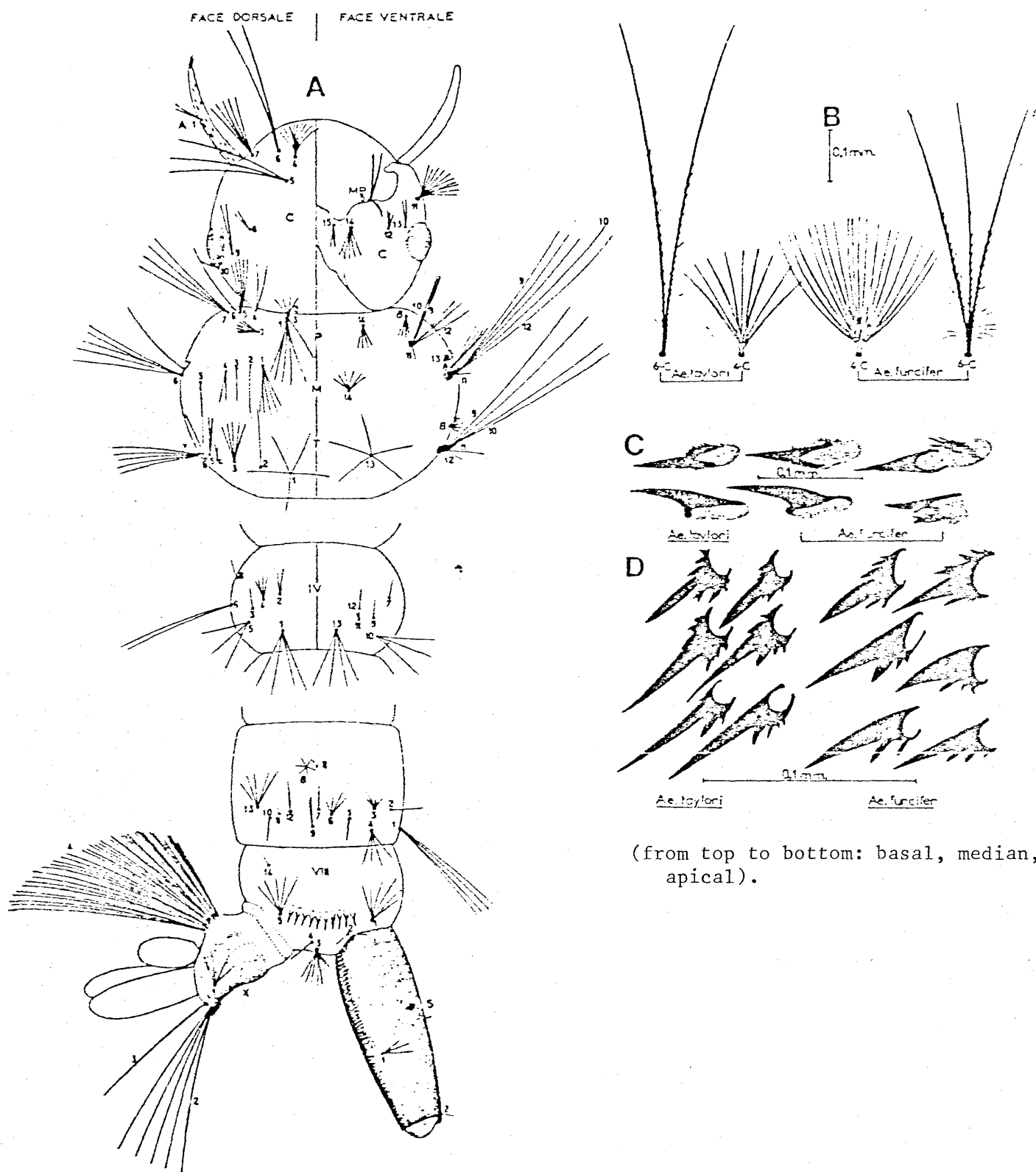
Out of the results shown in Table I and Figure 2 may be extracted the following 4 groups of characters, arranged in a series of increasing interest:

- 1) The following 12 characters may be considered as identical in A. furcifer and A. taylori, their mean values being equal or very nearly so: 8-C, 9-C, 10-C, 12-C, 13-C, 1-VIII, 2-VIII, 4-VIII, 2-S, 2-X, 3-X, 4-X;
- 2) The following 7 characters differ slightly from the one species to the other, because of restricted deviation in their values and means: 1-A, 6-C, 15-C, 6-MP, 3-VIII, 1-S, 1-X;
- 3) The following 7 characters and the siphonal index are very strongly different, if one refers to the significant breadth of distribution of their values and means, as well as to the non-negligible frequency of their specific values: 5-C, 7-C, 11-C, 14-C, 5-VIII, number of spines of segment VIII, and number of spines of the siphon;
- 4) One character seems rather species-diagnostic by reason of width of distribution of the values, the very broad difference in the means, and the great frequency of specific values: 4-C.

p. 18

~~p. 18~~
p. 20

pp. 22



(from top to bottom: basal, median, apical).

FIG. 1. — A : Chétotaxie partielle d'une larve d'*Ae. taylori*, selon la nomenclature de Knight et Laffoon (1971) : tête, thorax, segments IV, VII, VIII, X et siphon ; B : Soies 4-C et 6-C d'*Ae. taylori* et d'*Ae. furcifer* ; C : Épines du segment VIII chez *Ae. taylori* et *Ae. furcifer* (à droite : deux exemples d'épines anormales) ; D : Épines du siphon chez *Ae. taylori* et *Ae. furcifer* (pour chaque espèce, deux séries verticales correspondent à deux larves différentes ; de haut en bas : épines basales, médianes et apicales).

A: Partial chetotaxy of *A. taylori* larva according to nomenclature of Knight and Laffoon (1971), head, thorax, segs. IV, VII, VIII, and siphon; B - Setae 4-C and 6-C of *A. taylori* and *A. furcifer*; C - Spines of seg. VIII (2 abnormal spines at right); D: Spines of siphon (for each sp. 2 vertical series from 2 different larvae)

19

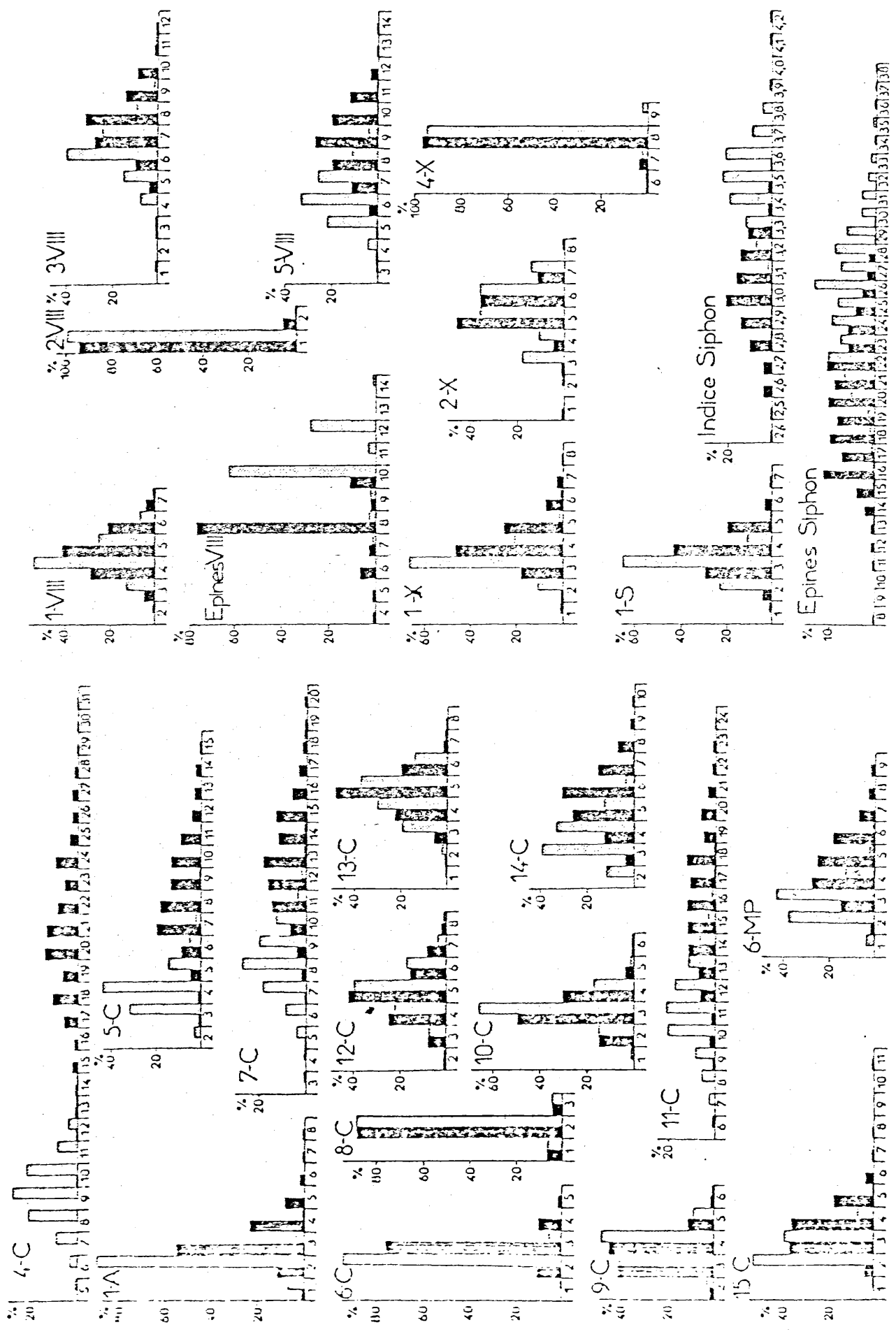
species characters	ESPECES	AE. TAYLORI		AE. FURCIFER		AE. T.	AE. P.	INTERET	
	CARACTERES	V.L.	MOY.	V.L.	MOY.	V.S.	V.S.		
antennal setae cephalic "	Soies anten. 1-A	1-4	2,0	1-8	3,4		5-8	+	
	Soies céphal. 4-C	5-14	9,1	10-31	20,5	5-9	15-31	+++	
	5-C	2-9	4,0	3-15	8,6	2	10-15	++	
	6-C	1-3	2,1	2-5	3,0	1	4-5	+	
	7-C	3-18	8,2	5-20	12,8	3-4	19-20	++	
	8-C	1-3	2,0	1-3	2,0				
	9-C	2-6	3,6	2-6	3,7				
	10-C	1-6	3,1	2-6	3,3	1			
	11-C	6-18	11,2	9-24	16,1	6-8	19-24	++	
	12-C	2-8	4,8	2-8	5,0				
	13-C	1-7	4,5	2-8	4,9	1	8		
	14-C	2-7	3,6	3-10	5,8	2	8-10	++	
	15-C	1-5	2,6	2-11	3,8	1	6-11	+	
	buccal setae	Soies bucc. 6-MP	1-6	2,8	2-9	4,8	1	7-9	+
	setae of segment	Soies sgt 1-VIII	2-7	4,3	3-7	4,9	2	8	
2-VIII		1-2	1,0	1-2	1,1				
3-VIII		1-11	6,2	3-12	7,7	1-2	12	+	
4-VIII		1	1	1	1				
5-VIII		3-11	6,3	4-14	9,0	3	12-14	++	
pectinal setae	Ep. peigne VIII	7-14	10,5	4-10	8,1	11-14	4-6	++	
siphonal setae	Soies siphon 1-S	1-5	2,9	2-7	3,9	1	6-7	+	
	2-S	1	1	1	1				
siphonal comb setae	Ep. peigne siphon	13-38	25,2	8-32	20,6 ^v	33-38	8-12	++	
siphonal index	Indice du siphon	2,8-4,2	3,5	2,4-3,6	3,0 ^v	3,7-4,2	2,4-2,7	++	
setae of segment	Soies sgt 1-X	1-6	3,1	2-8	4,3	1	7-8	+	
	2-X	2-8	5,5	1-7	5,5	8	1		
	3-X	1	1	1	1				
	4-X	6-9	8,0	6-8	8,0	9			

Table 1. Quantitative data relating to taxonomic characters of A. taylori and A. furcifer larvae: extreme values (VL); arithmetical mean (MOY); specific values (SV). Diagnostic interest graded from + to +++. Size of sample of each species in the order of 400 for individual setae and 200 for siphonal indexes.

TARLEAU I

Données quantitatives concernant les caractères taxonomiques étudiés chez les larves d'Ae. taylori et d'Ae. furcifer : valeurs limites (V.L.), moyenne arithmétique (MOY.) et valeurs spécifiques (V.S.). L'intérêt diagnostique va croissant de + à +++. Pour chaque espèce, les tailles d'échantillon sont de l'ordre de 400 valeurs pour les implantations de soies et de 200 valeurs pour les indices de siphon.

Fig. 1. Histograms of character values; frequency in % of total of data by character and by species (in gray - *A. taylori*; in black - *A. furcifer*)



p. 21

FIG. 2. — Histogrammes des valeurs de caractères. La fréquence des valeurs est exprimée en pourcentage du total des données, par caractère et par espèce (en gris : *A. taylori*, en noir : *A. furcifer*).

2.2. Qualitative Observations. Among the 27 characters studied quantitatively, 2 have constant differences between the species in their appearance. These are setae 4-C and 6-C. In A. furcifer, the branches of 4-C are longer and those of 6-C are shorter than in A. taylori. Their closeness on the cephalic capsule makes it easy to appreciate this difference. The measurements made on 30 specimens of each species show that the difference in A. furcifer is from 0.5 to 0.6 and in A. taylori it is rarely more than 0.3.

In A. furcifer, seta 4-C appears as a tuft, sometimes dense, of long branches hard to count; in A. taylori, seta 4-C seems small, with short, easily countable branches.

Under the binocular microscope, larvae of A. furcifer seem more "shaggy" than those of A. taylori. Examination of abdominal segment IV of 30 spms. of each species reveals the reason for this: the number^{OLS} of stellate setae (2 dorsal and 2 ventral pairs) have a mean of 5.0 branches in A. furcifer, while those of A. taylori have a mean of 3.8. The general pilosity is stronger in A. furcifer, also on the head and on segment VIII; in 19 characters pertaining to these 2 zones, the mean total of the branches of the setae is 122 for A. furcifer and 82 for A. taylori.

The shape of the pectinal spines of segment VIII is more homogeneous in one species than in the other and the shape of the siphonal pectinal spines is too variable within a single species for one to find a specific difference (Fig. 1C and 1D). The pectinal spines of segment VIII are hardly stronger and more robust in A. furcifer than in A. taylori.

3. DISCUSSION.

3.1. Comparison of our findings with previous findings. Table II permits a comparison of some of our results with those published by other workers.

It may be remarked first of all that there is little agreement between previous data and ours; one must recall that the only criterion of separation of the larvae of these 2 species proposed by Hopkins (1952) is:

- siphonal index less than 3.6.....A. furcifer
- siphonal index more than 4.....A. taylori.

Using this key, we can determine as A. taylori only 3 individuals out of our 213, that is, 1.4%.

Except the values cited by Lewis (1942), which for the most part are in our material, those which deal with characters other than the siphonal index show the same confusion. Doubtlessly the rare specimens described do not always belong to the species they are called.

3.2 DIAGNOSIS OF THE 2 SPECIES.

On the basis of the observations we have made, we propose a viable method for determining larvae of A. furcifer and A. taylori. The procedure is as follows:

- A - Count the total number of branches of setae 4-C : 2 (4-C);
 - if $2(4-C) = 30$ or more.....A. furcifer
 - if $2(4-C) = 20$ or less.....A. taylori
 - if $2(4-C) = 21$ to 29.....B
- B - Count the number of spines of each pecten on segment VIII;
 - if one pecten has more than 10 spines.....A. taylori
 - if neither has more than 10 spines.....C
- C - Count all spines on segment VIII (a) and all the siphonal spines (b);
 - if $a \times b =$ less than 800.....A. furcifer
 - if $a \times b =$ more than 800.....A. taylori

This diagnosis is more direct than it would seem at first glance if one considers that of the 436 larvae we had 401 (92%) immediately were determined at step A, 16 at steps A and B (3.6%), and only 19 (4.4%) had to be taken all the way.

3.3. Value of the diagnosis. The use of a nearly specific character, that of seta 4-C, the complementary use of a 2nd one (spines of segment VII), and the setting up of a score (the product of the total numbers of spines of segment VIII and of the siphon), suffices for the determination of all the Diceromyia in our study.

p. 22

p. 23

The other characters appear interesting and also useful, either directly for their evident specific value or for establishing indirectly combinatory values other than those we have used. For example, a score of 200 obtained as the product of the total number of branches of the 2 setae 5-C and those of the 2 setae 7-C is of satisfactory viability: it permits the determination of 191 out of 207 A. taylori and 123 out of 123 A. furcifer out of the lot of 339 Diceromyia. The error, close to 7%, is negligible if one knows that less than 5% of the sample enhances the use of a score obtained with a universal uncertainty of less than 4%.

We do not claim that our method is universal; the siphonal index of 5.4 mentioned by De Meillon (1943) for A. taylori permits the assumption of geographical variation (?) in which it is impossible to define taxonomic ranking. Nevertheless, we have demonstrated that it is easy to distinguish within a given area larvae of A. furcifer from those of A. taylori with great assurance.

If the key we have presented does not give complete satisfaction, any worker may adapt it to his particular situation without laborious research by our results. The methods employed are conclusive; the diagnostic importance of seta 4-C indicates this, and the specific values of the other characters have had their interest stressed.

It is worth noting how efficacious the determinations may be made by the simple macroscopic examination of the branching of seta 4-C and its relationships with 6-C (Fig. 2B). In the great majority of cases such an examination is sufficient.

p. 23
p. 24

3.4. Interest of the diagnosis. The interest of a viable diagnosis of the larvae of A. furcifer and A. taylori is multiple: 1) It is a study of usable reference, eventually, for the diagnoses of other Ethiopian species of the subgenus Diceromyia, sometimes sympatric: A. adersi Edwards, 1917; A. bananae Wolf, 1958; A. fuscipalpis Edwards, 1912; A. flavicollis Edwards, 1928; A. grassei Doucet, 1951; A. mefouensis Ferrara, 1974; A. sylvaticus Brunhes, 1982; A. tiptoni Grjebine, 1953; A. zethus De Meillon & Lavoipierre, 1944 (in Knight & Stone, 1977, 1978; Brunhes, 1982; Ravaonjanahary, 1978); 2) Inasmuch as ecological studies and research on the prevalence of

SPECIES	Aedes taylori					Aedes furcifer				
	AUTHORS CHARACTER	Lewis 1942	De Meillon 1943	Hopkins 1952	Muspratt 1955	Present study	Lewis 1942	Hopkins 1952	Muspratt 1955	Present study
1-A		1/2	2/7			1/4		2/3		1/8
4-C		6/10	12/22			5/14	13			10/31
5-C		3/5	6/11		3/10	2/9	5/6	3	3/10	3/15
6-C		2	2/3			1/3	2/3	3		2/5
7-C		6	7/14		various	3/18	9	7	various	5/20
Spines VIII		10	8/10			7/14		8/10		4/10
1-S		2/3	2/5			1/5	4	3	1 & +	2/7
Siphon spines		20/22	14-29			13/38	20/29	13/25		8/32
Siphon index		4.3/4.4	5.4	4 & +		2.8/4.2	3.3/3.6	2/3.6		2.4/3.6
1-X		3/4				1/6		4		2/8
2-X		6/7				2/8		6		1/7
3-X		1				1		1		1
4-X		8				8/9				6/8

Table II. Comparison of part of present study with data of available previous work.

vectors of arboviruses has yielded material that must be specifically determined, the larvae can now be determined without individual rearing, which is always tiresome; in 1983 we determined to species, after cold anaesthesia, 2000 larvae of Diceromyia collected in our forest areas, and the adults emerging from these and preserved for verification have confirmed the exactitude of the determinations; 3) Work on the transovarian transmittal of arbovirus can now be done directly on larvae, a thing that until now would have been impracticable.

CONCLUSION. It is now possible in a simple and viable manner to determine both adults and larvae of A. furcifer and A. taylori as shown in the recent work of Ferrara, Germain, and Hervy (1984) and in the present work. Now that these 2 Diceromyia are known to be important vectors of yellow fever and dengue in western Africa, there is no longer any reason to maintain the "furcifer-taylori" group designation, because it is more important than ever to know precisely what role each species plays in the epidemiological cycles of these arboviruses.

ACKNOWLEDGMENTS. We thank Messieurs A. Challier and M. Germain for the care they have taken with our manuscript.

Manuscript accepted by the Editorial Committee on 5 January 1985.

BIBLIOGRAPHY

- BRUNNES (J.), 1962. — Culicidés de Madagascar. IX. Complément à la description d'*Aedes (Diceromyia) grassii* Doucet, 1951 et description d'*Aedes gyanicus* n. sp. (Diptères, Nématocères). *Cah. ORSTOM, sér. Ent. méd. et Parasitol.*, 20, 4 : 313-318.
- DE MEILLON (B.), 1943. — New records and new species of Nematocera (Diptera) from the Ethiopian Region. *J. ent. Soc. Sth. Afr.*, 6 : 90-113.
- FERRARA (L.), GERMAIN (M.) et HERVY (J. P.), 1984. — *Aedes (Diceromyia) furcifer* (Edwards, 1913) et *Aedes (Diceromyia) taylori* Edwards, 1936 : le point sur la différenciation des adultes. *Cah. ORSTOM, sér. Ent. méd. et Parasitol.*, 22, 3 : 179-183.
- HOPKINS (G. H. E.), 1952. — Mosquitoes of the Ethiopian Region. I. Larval bionomics of mosquitoes and taxonomy of culicine larvae. The British Museum (Natural History), London, 555 p.
- KNIGHT (K. L.) et LAFFOON (J. L.), 1971. — A mosquito taxonomic glossary. VIII. The larval chaetotaxy. *Mosq. Syst. Neustroica*, 3, 4 : 160-194.
- KNIGHT (K. L.) et STONE (A.), 1977. — A catalog of the mosquitoes of the world. The Thomas Say Foundation, Ent. Soc. of Amer., College Park, 611 p.
- KNIGHT (K. L.) et STONE (A.), 1978. — Supplement to a catalog of the mosquitoes of the world. The Thomas Say Foundation, Ent. Soc. of Amer., College Park, 107 p.
- LEWIS (D. J.), 1942. — The early stages of *Aedes taylori* Edwards and *A. furcifer* Edwards (Dipt., Culicidae). *Proc. R. ent. Soc. Lond. (B)*, 11 : 153-154.
- MUSPRATT (J.), 1945. — Observations on the larvae of tree-holes breeding Culicini (Diptera, Culicidae) and two of their parasites. *J. ent. Soc. Sth. Afr.*, 8 : 12-20.
- RAVAONJANAHARY (C.), 1978. — Description complémentaire d'*Aedes (Diceromyia) taylori* Grjebine, 1953. *Cah. ORSTOM, sér. Ent. méd. et Parasitol.*, 16, 2 : 99-103.