DIPLONYCHUS, LAPORTE (=HYDROCYRIUS, SPINOLA), AND ITS RELATION TO THE OTHER BELOSTOMATID GENERA.

BY J. R. DE LA TORRE BUENO, NEW YORK.

The genus *Hydrocyrius* was founded in 1850 by the Marquis Maximilian Spinola,[1] and since then it has figured under that name. It has been redescribed several times under different appellations. Stål called it *Ilyotrephes*;[2] A number of other authors[3] have treated it as a species of the old genus *Belostoma*, Auctt. (now *Amorgius*, Stål). But the question nevertheless arises, "Is this the true generic name, or have we another valid appellation for the genus?" In consulting a number of works and papers for material for these notes on the affinities of *Hydrocyrius*, Laporte de Castelnau's[4] definition of the genus *Diplonychus* attracted my attention. It reads thus: "Antennæ breves, sub oculos in excavatione insertæ, articulis 4; ultimis 3 subpectinatis. Rostrum breve, arcuatum, acuminatum. Tarsi articulis 2; ungulis 2.

"Faciès des Bélostomes; l'abdomen des femelles est terminé par deux longs filets.

"Ier Sous-genre. *Diplonychus*, Mihi.

"Corpus elongatum; tarsorum anticorum unguiculis elongatis. *Belostoma rustica*, FAB., 106, 3.

"Et plusieurs autres espèces exotiques.

"IIme Sous-genre. *Sphærodema*. Mihi, etc."

Further on in the same work (p. 83) he states: "C'est par erreur que j'ai indique (page 18) le *Belostoma rustica* de Fabricius, comme type du genre *Diplonichus* (!). Cet insecte est un *Sphærodema*."

Now, according to my understanding of Kirkaldy's views on the historical method of type fixation,[5] this leaves the subgenus without a type species. The fact that subsequent authors have raised the subgenus to full generic standing, and that under it they have grouped Belostomatids with two *short* claws, in no way invalidates the original description, which specifically indicates that in the typical subgenus *Diplonychus* the claws of the anterior tarsi are *elongate*. Moreover, the

1. 1850, Mem. Mat. Soc. Modena, xxv, 146.

2. 1856, Ofv. Vet. Ak. Förh, p. 358.

3. Dufour, Belostoma algeriense; Lucas, B. grande; Guérin, B. capitatum; Coinde, B. cosmopolitanum.

4. 1832, Essai d'une Class. Hém. p. 18 (of separate).

5. 1905, Proc. Ent. Soc. Wash., Vol. XII, pp. 27 to 28.

body is stated to be *elongate*. Now, no species of the genus or genera variously known as *Atomya*, Spinola; *Appasus*, Amyot and Serville; *Cyclodema*, Dufour; *Nervinops*, Dufour; *Sphærodema*, Auctt., and *Diplonychus*, Amyot and Serville, of those that I have seen (and my collection contains nearly all the known species which at one time or another have been ranged in these genera), is *elongate*. All are more or less ovate. This view was enunciated by Leon Dufour in his "Essai Monographique sur les Bélostomides,"[6] who then said under *Hydrocyrius*, Spin. (p. 385): "On a peut être mal interpreté le genre *Diplonychus* fondé en 1832, par M. de Laporte. Cet auteur dit positivement que les *Diplonychus* ont le faciès des *Belostoma;* que leur corps est *elongatum*, que les tarses antérieurs se terminent par deux ongles *elongati*. Je le demande aux esprits sérieux, ces traits sont-ils applicables aux *Diplonychus* des auteurs de l'epoque? Quant à moi qui ai etudié à fond cette question, j'ai l'intime conviction que le Diplonychus de M. de Laporte a du être primitivement, fondé sur un grand *Bélostome*, analogue à mon *Algeriense*."[7]

Prof. Montandon has discussed the synonymy of this genus in one of his able essays on Water-bugs,[8] and his conclusion is that *Diplonychus*, Lap., being unidentifiable, it is better dropped for the defined *Sphærodema*, Lap., although he suggests that Laporte may have had before him a nymphal Belostomatid (which is two-clawed) or a species of *Hydrocyrius*. In his discussion, however, it is evident that he is unfamiliar with Laporte's later note cited above, in which he removes *Belostoma rustica*, Fab., from the subgenus, and states that it is a *Sphærodema*. While it is true and proven that nymphal *Belostomatids* are two-clawed, none of those known to me have the so-called "filets abdominaux" or "caudal setæ." These are characteristic of the adult only, and are *not* sexual characters, but rather pertain to the respiratory apparatus, and are parts of the highly specialized and modified sixth abdominal segment. I am familiar with all but one of the described Belostomatid genera, and know about fifty species, but of these the only ones that have the "facies des Belostomes," and are at the same time two-clawed, are the two species of *Hydrocyrius* I possess.

6. 1863, Ann. Soc. Ent., Fr. (4), III.

7. =columbiæ, Spin. (Hydrocyrius).

8. 1900. Notes s. qqs. genres de la Fam. Belostomidæ—Bull. Soc. Sci. Buc. An. IX, No. 2 and 3, pp. 1 to 8 (of separate).

My friend Kirkaldy, in his recently-published list of genera,[9] rejects Montandon's work and adopts *Diplonychus*, Lap., as the true generic appellation of the *Sphærodema-Appasus-Nervinops-Cyclodema-Atomya* series, but in consideration of the facts I have here set forth, the correct synonymy, which may be intercalated in Kirkaldy's generic list, p. 151, is as follows :

Genus 5.—*Sphærodema*, Laporte, 1832, Essai Hem., 18 (type fig. in Fieber, etc.). The rest of the synonymy as in Kirkaldy, l. c .....Type *annulata*, Fabr.

Genus 7.—*Diplonychus*, Laporte, 1832, Essai, p. 18.
= *Hydrocyrius*, Spinola, 1850, etc. (The remainder of the synonymy as in Kirkaldy, l. c., p. 152.)

II.

What is the true systematic position of *Diplonychus*, Lap. (= *Hydrocyrius*, Spinola)? Kirkaldy in his work cited places *Hydrocyrius*, Spin. (recte *Diplonychus*, Lap.), between *Limnogeton*, Mayr, and *Nectocoris*, Mayr, this genus being placed last in the family. Going further back, Mayr[10] places it between *Benacus*, Stål, and *Limnogeton*, Mayr, and so does Stål.[11] Dufour,[12] however, seems to have been the only one of the older entomologists to have had the true conception of the affinities of *Diplonychus*, Laporte (= *Hydrocyrius*, Spinola). He places it between *Belostoma*, Auctt., nec Latr. (= *Amorgius*, Stål), and *Zaitha*, Am. & S. (= *Belostoma*, Latreille). Agreeing with Dufour, I believe the linear relationship of the Belostomatid genera is more nearly expressed by the following order :

1. *Benacus*, Stål.
2. *Amorgius*, Stål.
3. *Diplonychus* (Laporte), Bueno.
4. *Belostoma*, Latreille.
5. *Abedus*, Mayr.
6. *Limnogeton*, Mayr.
7. *Nectocoris*, Mayr.
8. *Sphærodema*, Laporte.

9. 1906, List of the Genera of the Pagiopodous Hemiptera, etc., Tr. Am. Ent. Soc., XXXII, No. 2, pp. 117 to 156 and 156a.

10. 1871, Die Belostomiden, Verh. Zool. bot. Geo. Wien., XXI.

11. 1865, Hem. Afr., III.

12. 1863, Ess. Mon. s. l. Belost., Ann. Soc. Ent. Fr. (A.) III.

These genera may be separated by the following table:

1. (2) Anterior femora not sulcate.....I, *Benacus*, Stal.
2. (1) Anterior femora sulcate.
3. (10) Anterior tarsi with two claws.
4. (9) Claws of anterior tarsi of equal length, minute.
5. (8) Anterior femora more or less incrassate, much larger than tibiæ.
6. (7) Species with two sulci between the eyes .VII, *Nectocoris*, Mayr.
7. (6) Without such sulci .....VIII, *Sphærodema*, Lap.
8. (5) Anterior tarsi scarcely incrassate, but little larger than tibiæ.....VI, *Limnogeton*, Mayr.
9. (4) Claws of anterior tarsi of equal or unequal length, elongate .....III, *Diplonychus*, Lap. (Bueno).
10. (3) Anterior tarsi with one claw.
11. (14) Head conically produced, rostrum long, thin.
12. (13) Membrane of hemelytra large..... .IV, *Belostoma*, Latr.
13. (12) Membrane of hemelytra much reduced.....V, *Abedus*, Stal.
14. (11) Head not conically produced, rostrum short, stout.....II, *Amorgius*, Stal.

A brief study of the three genera, *Amorgius*, Stal; *Diplonychus*, Laporte (Bueno), and *Belostoma*, Latreille, is necessary in order to elucidate my position. The difference between the adults of the three genera will appear from the following comparisons:

The Head.—In *Amorgius* we have the front truncate, projecting but little beyond the eyes, which are in general longer than broad. The vertex also is not wider than one eye, and is more or less conical in shape, as is *Belostoma*. But in *Diplonychus* the vertex is not wider than the eye, while in *Belostoma* it is. In both the eyes are wider than long. The rostrum in *Amorgius* is quite short and stout, and in *Belostoma* very long and slender, whilst in *Diplonychus* it is moderately long, and as stout as in the first-named genus. The prothorax is trapezoidal in all three genera, but is much less narrowed anteriorly in *Diplonychus* than in the other two, which gives it a massive aspect. The scutellum also is apparently large, due to the more stout general build of this bug. The hemelytra are much the same in the three except for slight variations, which are no greater than those occurring in the different species of any one genus. *Diplonychus* agrees with *Amorgius* in the general outline, the sides being more or less parallel, whilst in *Belostoma* the body is more or less pointed oval posteriorly. We now come to the under side of the body and the legs. The

genital plate in *Diplonychus*, as in *Belostoma*, is entire, while in *Amorgius* it is deeply fissured medianly. In shape it is much the same throughout the family, although much shorter in *Belostoma* than in the other two genera. The tibiæ of the third pair of legs in *Amorgius* is flattened, more or less broad, heavily fringed with long hairs, and terminates in two long claws. *Belostoma* and *Diplonychus*, on the other hand, have prismatic posterior tibiæ, and the hairs are shorter. The form of the intermediate tibiæ is the same in each genus as the posteriors. It is in the anterior pedes that the most interesting features occur. The femora are incrassate in all three, but while in *Belostoma* they are only moderately so, in *Diplonychus* and *Amorgius* they are greatly so. All three genera have them deeply sulcate for the reception of the tibiæ, which are of similar shape in all. The tarsal joints are moderately long and equal in *Belostoma*. In *Amorgius* and *Diplonychus* they are small and unequal. The profound yet most significant character is contained in the anterior tarsal claws. These are single, long in *Amorgius*, and small in *Belostoma*. In *Diplonychus* they are *double* and *long*, though the outer is but half the length of the other in the two species known to me, while in one described by Mayr they are of equal length. The importance of this structural feature can be appreciated only from the study of the nymphs taken in conjunction with the changes that occur in the claws during development. As various authors[13] have from time to time pointed out, Belostomatid nymphs of the several genera are all two-clawed in the anterior tarsi throughout all, or in some of the earlier, instars. In general, the nymphs of *Amorgius* possess two elongate equal claws up to the last moult, one of which they lose at that ecdysis, and the adult has only one more or less long tarsal claw. In the several nymphs of *Belostoma*, as I have elsewhere noted,[14] some lose the one claw early, others by slow stages,[15] at some one of which the length of one claw bears the same relation to the other as the adult in *Diplonychus* known to me. In this last-named genus, however, the nymph in the last instar has the two long claws of equal length,[16] as in *Amorgius*. At the last moult in two species one of these claws is reduced to half the length of the other, while in the third, known to me only by description, the two equally long claws are preserved.

13. 1863, Dufour, op. c.; 1871, Mayr, op. c.; 1901, Howard, Ins. Bk., p. 279; 1906, Bueno, CAN. ENT., XXXVIII, p. 197; and others.

14. Op. c.

15. Cf. *B. fluminea*, op. c.

16. Duf., Ann. Soc. Ent. Fr. (A.)III, p. 386, description of nymph in last instar of *Hydrocyrius algeriensis*.

The egg-laying habits of *Diplonychus* are as in *Belostoma*,[17] in which genus (as well as in several others of the family) the female fastens the eggs on the back of the male. *Amorgius*, however, deposits its ova under a convenient log or plank in a damp spot at the water's edge, glued to it, which also appears to be the habit with *Benacus*.[18] To recapitulate: *Diplonychus*, Lap. (Bueno), approaches *Belostoma*, Latreille, in the shape of the eyes, the genital plate, the posterior and the intermediate tibiæ, and in the manner of oviposition. It is close to *Amorgius*, Stål, in the form of front and vertex, general shape, anterior femora, tibiæ and tarsal joints, and in the claws in the nymph. It is intermediate in the rostrum, which tends to the *Amorgius* side. It resembles both genera in the shape of the scutellum, in the membrane, of the hemelytra, and in most of the other features not dwelt upon. The differences are the general shape of the head, which is very broad, the shape of the prothorax, and, above all, in the possession of two long claws in the adult, of equal length in one known species, and unequal in the other two. From this last character, taken in conjunction with the nymphal structure of these appendages in the two allied genera, as well as in the others of the family, we may in fairness conclude: 1st. That *Diplonychus* is an intermediate form in the chain of development linking the Amorgioid forms to the Belostomoids; and 2nd. That it is in all likelihood the most primitive form of the Belostomatid series, from which arise the genera *Amorgius*, Stål, and *Benacus*, Stål, on the one hand, and *Belostoma*, Latr.; *Abedus*, Mayr; *Limnogeton*, Mayr; *Sphærodema*, Lap., and *Nectocoris*, Mayr, on the other.

To sum up, it would appear that *Diplonychus*, Laporte (Bueno), is nearly allied to both *Belostoma*, Latr., and *Amorgius*, Stål, with closer leanings to the latter, and that its systematic position is as given in the linear arrangement between these two genera.

III.

The species and distribution of *Diplonychus*, Lap. (Bueno), are moot questions. A great deal of confusion has arisen from the description and rediscription of what is said to be one species from several widely-separated localities. I recognize three species, but it is more than likely that some of those reduced to synonymy may be later revived as our knowledge of

17. 1906, Bueno, op. c. p.; 1900, Horvath in Lit., quoted by Mont. Bull. Soc. Sci. Buc. An. IX, No. 2 and 3, p. 8.

18. 1889, C. M. Weed, Studies in Pond Life, Bull. Ohio Agr. Exp. Sta., Tech. ser., I, No. 1; 1907, Needham, Ent. News, XVIII, pp. 113 to 116.

the genus and the group at large increases. They are *Diplonychus columbiæ*, Spinola; *D. punctatus*, Stål, and *D. rectus*, Mayr, the two first of which I am acquainted with in nature, and the latter by description. They may be separated as follows:

KEY TO THE SPECIES OF *Diplonychus*, Laporte.

1. (2) Anterior tarsi furnished with two claws of *equal* length.....III, *rectus*, Mayr.
2. (1) Anterior tarsi furnished with two claws of *unequal* length.
3. (4) Disk of prothorax punctate, with two pronounced round foveæ, hemelytra more or less punctate..... ... II, *punctatus*, Stål.
4. (3) Disk of prothorax slightly punctate, with two shallow foveæ and two sulci converging posteriorly toward the transverse sulcus, hemelytra impunctate.....I, *columbiæ*, Spinola.

I.—*Diplonychus columbiæ*, Spin.

Hydrocyrius columbiæ.

1850.—Spin., Mem. Nat. Soc. Modena, XXV, 146.
1863.—Duf., Ess. Mon. Bel., Ann. Soc. Ent. Fr. (4), III, 385.
1864.—Lucas, Ann. Soc. Ent. Fr., IV., 228.
—Signoret, op. c., 224.
1865.—Mayr, Reise der Novara, Hem., p. 183.
1871.—Ibid, Die Belostomiden, Verh. Zool.-bot. Ges. Wien, XXI, 429, part.
1886.—Uhler, Ch. List, p. 28.
1895.—Schmidt (Schwedt), S. B. Ges. Nat. Freunde Berlin, p. 38.
1900.—Montandon, Bull. Soc. Sci. Nat. Buc. An. IX, No. 2 and 3, p. 4.
1901.—Champion, Biol. Cent. Am., Het., II, 362.

Belostoma grande.

1849.—Lucas, Hist. Nat. An. Art. Alg., III, 43.
1862.—Ibid, Ann. Soc. Ent. Fr., II, 404.
1864.—Ibid, op. c, IV, 227.

Ilyotrephes herculeus.

1853.—Stål, Öfv. Vet. Ak. Förh., V, 264.

Hydrocyrius herculeus.

1866.—Stål, Hem. Afr., III, 181.

Belostoma algeriense.

1855.—Duf., Mem. Soc. Ac. Sci. Liege, X, 187, pl. I, f. 1.
1862.—Lucas, Ann. Soc. Ent. Fr. II, 404.

Belostoma capitatum.

1856.—Guérin, in Sagra's Hist. Cuba, An. Art., VII, 420.

1865.—Mayr, Reise der Novara, Hem., p. 183.

Belostoma cosmopolitanum.

1863.—Coindé, Rev. Mag. Zool., 33.

1864.—Lucas, Ann. Soc. Ent. Fr., IV, 227.

Ever since this species was first described, it has been recorded from time to time from the most widely-separated places. The distribution, as given by Dufour and Mayr, is as follows :

America.—Mexico and Cuba.

Africa.—Algeria, Khartoum, Guinea, Caffraria and Madagascar. This distribution, however, seems to me too scattered to be real.

Mexico is given following Spinola, while under the supposition that *Belostoma capitatum*, Guér., is the same insect, the Cuban record comes into existence. Madagascar is given by Mayr, on the ground that *punctatus*, Stål, described from the Island, is merely a synonym of *columbiæ*, Spinola. This is not the case, however, as the former is readily distinguishable from the latter, as may be seen by the analytical table. The homogeneity, so to say, of the other localities, added to the fact that in Algeria at least the Hemipteron seems to have been fairly common, would appear to establish them as real beyond reasonable doubt. In addition, I have a specimen from German East Africa. It may, therefore, be safely stated that the bug is African, and that it is spread over the greater part of the continent. Its existence in America is problematical, to say the least, and although Champion refers to it in Biologia Centrali Americana, he does not list it, but states as his opinion that "In addition to the species enumerated here, two others have been recorded from Mexico, but further evidence is required before they can be included in our list; these are *Hydrocyrius columbiæ*, Spinola," etc. In confirmation of this, my personal endeavours to secure the bug, either from Cuba or Mexico, have thus far proven fruitless. It seems best, therefore, to ignore the American records, at least till they are absolutely confirmed or disproved.

II.—*Diplonychus punctatus*, Stål.

Hydrocyrius punctatus.

1865.—Stål, Hem. Afr., III, 182.

H. columbiæ, partim.

1871.—Mayr, Die Belostomiden, Verh. Zool.-bot. Ges. Wien, XXI, pp. 429, 430.

This bug was reduced by Mayr to synonymy, and evidently he did not consider it more than a local variety. In fact, he says so in so many words (op. c., p. 430). The species, however, is well marked. Stal recorded it from Madagascar originally, and it does not appear to have been mentioned since. I possess a specimen from that Island. It is apparently restricted to that territory.

III.—*Diplonychus rectus*, Mayr.

Hydrocyrius rectus.

1863.—Mayr, Verh Zool.-bot. Ges. Wien, p. 359.

1864.—Signoret, An. Soc. Ent., Fr. (4), IV, 224.

1871.—Mayr, Die Belostomiden Verh Zool.-bot. Ges. Wien, XXI, 430.

No other records are to be had of this well-defined species than that of the author, who gives Sierra Leone (West Africa) as its habitat. It is 10 mm. shorter than *punctatus*, Stal, from which the character given in the table at once separates it.

In conclusion, I wish to express my thanks to Mr. G. W. Kirkaldy, whose independent investigation when I called his attention to the generic emendation proposed, confirmed the conclusion I had already reached. He added in his letter other important synonymical matter, which it is to be hoped he will make public ere long.

PRACTICAL AND POPULAR ENTOMOLOGY.—No. 23.

Fumigation with Hydrocyanic Acid Gas for Bedbugs.

BY GLENN W. HERRICK, AGRICULTURAL COLLEGE, MISS.

Fumigation of a Large Building.

For the past two years we have used hydrocyanic acid gas on an extensive scale with considerable success, and thinking that the experience gained might be of benefit to other workers who may be confronted with the same problem it seemed worth while to give an account of the work and method of procedure.

Our dormitory building, in which the work has been done, is a large 4-story structure in the form of an E, and contains, all told, 253 rooms of different sizes on the different floors. We use approximately the formula recommended by Dr. L. O. Howard in Circular 46, s.s., the only change