AN ENUMERATION OF THE CRUSTACEA DECAPODA NATANTIA INHABITING SUBTERRANEAN WATERS

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The present paper provides a list of the macrurous Decapod Crustacea, belonging to the supersection Natantia, that have been found in subterranean waters. The number of such species is quite small, being somewhat more than 40 in all. Of these only part are actual troglobic forms, i.e. animals that are only known from caves and have not, or only incidentally, been found in waters that are exposed to daylight. A second group is formed by species that normally live in surface waters and only occasionally are met with in subterranean habitats. No sharp line can be drawn between these two categories, the more so as at present still extremely little is known of the biology and of the ecology of most of the species. Nevertheless it was thought useful to try and make in the present paper a distinction between these two groups, of each of which a separate list is given enumerating the species in systematic order. In the first list the true troglobic forms are dealt with, the second contains those species which must be ranged under the incidental visitors of subterranean waters. Of the species placed in list I a complete synonymy is given, while also all the localities whence the species has been reported are enumerated. Furthermore remarks are made on the ecology and biology of the animals as far as these are known. In the second list only those references are cited that deal with specimens found in subterranean waters, while also some notes on the ecology of the animals and the general distribution of the species are provided.

Four new species, all four placed in group I, are diagnosed here; more extensive descriptions of them will be published later.

I. — LIST OF TROGLOBIC DECAPODA NATANTIA

The troglobic Decapoda Natantia belong to three families, viz., the Atyidae, the Palaemonidae and the Hippolytidae, they are found in the tropical and temperate regions of the world and live in fresh or brackish water.

FAMILY ATYIDAE

TROGLOCARIS Dormitzer, 1853.

This genus consists of four species, all of which are troglobic. Subspecies of some of these have been recognized.

Troglocaris inermis Fage, 1937.

Troglocaris Schmidti inermis FAGE, 1937, p. 215, fig. 1-6; JEANNEL, 1943, p. 270; BONNET, BOURNIER, DU CAILAR et QUEZEL, 1951, p. 342.

Troglocaris schmidti inermis BIRSTEIN, 1939, p. 962; BIRSTEIN, 1948, p. 6, 7, 8 ; BALAZUC, BONNET, BOURNIER et DU CAILAR, 1951, p. 84 ; JUSBASCHJAN, 1951, p. 504, 505, fig. 2, 9^{II}.

Distribution. Type locality : Grotte de Cambous, near St-Hippolyte-du-Fort, dépt. Gard, S. France (FAGE, 1937). Additional localities : Grotte des Cent Fonts near Causse-de-la-Selle, dépt. Hérault, S. France (BALAZUC, BONNET, BOURNIER et DU CAILAR, 1951; BONNET, BOURNIER, DU CAILAR et QUEZEL, 1951), ? Aven de la Baraque and Grotte du Lirou near Les Matelles, dépt. Hérault, S. France (BALAZUC, BONNET, BOURNIER et DU CAILAR, 1951).

Ecology. The species is found in fresh subterranean waters. FAGE (1937) reports it from pools left behind by a subterranean stream after a period of high water.

Biology. The animal is perfectly transparent, showing no pigment, not even in the eyes, which are strongly degenerated and possess no optical elements. It is very agile, jumps well, and is hard to catch. Ovigerous females have been observed in September and December. M. DE JOLY, who collected the types of this species, became aware of the presence of the animals in the subterranean pool in which he was swimming, by a feeling of being stung in several places on his back. These stings proved to be caused by specimens of *Troglocaris inermis*, which by their perfect transparency were not visible in the water (JEANNEL, 1943). According to JEANNEL these stings were caused by the rostrum, which, taking the shortness of this organ into account,

does not seem very probable. It is a well known fact that Palaemonids actually nibble at the legs of human beings standing in the water, but so far as I am aware this has not been reported for Atyids. If Atyids in this respect resemble Palaemonids the stings felt by M. DE JOLY actually may have been bites.

Troglocaris anophtalmus anophthalmus (Kollar, 1848).

Palaemon anophtalmus KOLLAR, 1848, p. 137.

Palaemon anophthalmus FREYER, 1849, p. 58; DORMITZER, 1853, p. 85; HOLTHUIS, 1955, p. 21.

Palomon anophthalmus SCHIÖDTE, 1851, p. 157.

Troglocaris Schmidtii DORMITZER, 1853, p. 85; HELLER, 1863, p. 240; JOSEPH, 1881, p. 237, 241, 246, 249, 250, 276, 277, 279; JOSEPH, 1882, p. 12; MONIEZ, 1889, p. 256; HAMANN, 1897, p. 521.

Troglocaris Schmidlii DORMITZER, 1853, pl. 3.

Tryglocaris Schmidtii JOSEPH, 1875, p. 27.

Troglocaris Schmidti SIMON, 1875, p. 114; HAMANN, 1896, p. 225, pl. 5, fig. 1; BOUVIER, 1904, p. 129; BOUVIER, 1905, p. 65, fig. 2; BOUVIER, 1925, p. 81, fig. 148-158; WICHMANN, 1926, p. 130; CHAPPUIS, 1927, p. 89, 151 ; MÜLLER, 1931, p. 206 ; FAGE, 1937, p. 222, 224 ; JEANNEL, 1943, p. 269; HOLTHUIS, 1955, p. 21.

Troglocaris schmidti ORTMANN, 1895, p. 401 ; HAY, 1903a, p. 229, 230 ; PERKO, 1906, p. 43-58 ; VALLE, 1911, p. 22-26 ; BABIĆ, 1922, p. 300; STAMMER, 1932, p. 543, 545, 553, 557, 605, fig. 15, 16; STAMMER, 1933, p. 264; WOLF, 1934, p. 101; EDMONDSON, 1935, p. 15; p. p. KARAMAN, 1935, p. 63 ; STAMMER, 1935, p. 94, 95 ; STAMMER, 1935a, p. 518, fig. 1, 2; STAMMER, 1937, p. 1052; CHACE, 1943, p. 26; BEATTY, 1949, p. 336, 338, fig. 1a ; JUSBASCHJAN, 1951, p. 502 ; KARAMAN, 1954, p. 199, fig.

Troglocaris schmidtii CALMAN, 1909, p. 93 ; SPANDL, 1926, p. 92, 141, 145, 146, 181, 189, fig. 61 ; STAMMER, 1932a, p. 515, 516 ; BIRSTEIN, 1933, p. 150, 151 ; BIRSTEIN et VINOGRADOV, 1934, p. 42 ; WOLTERECK, 1937, p. 325.

Troglocaris Schmidti Schmidti forma *typica* FAGE, 1937, p. 226, fig. 9.

Troglocaris schmidti schmidti BIRSTEIN, 1939, p. 962; BIRSTEIN, 1948, p. 5, 7, 8; JUSBASCHJAN, 1951, p. 504, 505, fig. 9[1].

Troglocaris anophthalmus HOLTHUIS, 1947, p. 313; HOLTHUIS, 1955, p. 22, fig. 6c; ROTH-WOLTERECK, 1955, p. 197, 198.

Troglocharis Schmidti JEANNEL, 1950, p. 49 (not fig. 5), 59.

Distribution (1). The species is found in the region N.-E. of the Adriatic Sea. The localities are the following. Italy, province of Venezia Giulia : Well near Monfalcone (MÜLLER, 1931; STAMMER, 1932, 1932a). Free territory of Trieste : Pozzo dei Colombi and a nameless well near San Giovanni di Duino (MÜLLER, 1931; WOLF, 1934), small cave near the Timavo River (STAMMER, 1932, 1935a), Grotta di Trebiciano (= Lindnergrotte) near Trieste (VALLE, 1911; STAMMER, 1932, 1932a, 1935a). Yugoslavia, Istria : Artificial well at Pulj (= Pola) (MÜLLER, 1931), Hotiska Jama (= Hoticina) near Cotticina (PERKO, 1906), Grotta Lethe, Odolina near Matteria (HAMANN, 1896, 1897; BOUVIER, 1904, 1905, 1925). Yugoslavia, Carniola : Erjavščika Cave near Tarnova, N.-E. of Gorizia (STAMMER, 1935a), cave (Grotta del fiume sotterraneo) near Slavina, region of St. Peter (= San Pietro del Carso) (MÜLLER, 1931; WOLF, 1934), Postojna (= Postumia, = Adelsberg) Cave (HELLER, 1863; JEANNEL, 1950), Cerna Jama (= Grotta Nera, = Schwarze Grotte, = Magdalenengrotte) in Postojna Cave (CHAPPUIS, 1927; MÜLLER, 1931; STAMMER, 1932), Logarček Cave (= Graf Falkenhayn Höhle) near Planina (STAMMER, 1935a), Podtiskavec Cave near Struge, S.-E. part of Guttenberg Valley (KOLLAR, 1848; WOLF, 1934), Kumpolska Jama near Kumpolje (KOLLAR, 1848; DORMITZER, 1853; JOSEPH, 1875, 1881, 1882; HAMANN, 1896; BOUVIER, 1904, 1905, 1925; STAMMER, 1935a), Ljubljana (= Laibach) (FAGE, 1937), Obergurker Höhle near Krka (= Gurk) (DORMITZER, 1853; JOSEPH, 1881, 1882; HAMANN, 1896, 1897; BABIĆ, 1922; BOUVIER, 1925), Klindorfer Wasserloch near Kočevje (= Gottschee) (WICHMANN, 1926). Yugoslavia, Hercegovina : Vjetrenica Cave near Zavala (STAMMER, 1935, 1935a), Popovopolje (BEATTY, 1949). The type localities of *Palaemon anophtalmus* Kollar are the Kumpolska Jama and the Podtiskavec Cave, those of *Troglocaris Schmidtii* are the Kumpolska Jama and the Obergurker Höhle. As the restricted type locality of both species I select here the Kumpolska Jama.

The specimens from Hercegovina may belong to the subspecies *intermedia* Babić and not to the typical form.

Ecology. The species is found in fresh subterranean waters. It lives practically exclusively in total darkness (MÜLLER, 1931, mentioned

(1) Most of the Yugoslav localities cited here, before World War I were situated in Austrian territory. Between World Wars I and II a large part of these former Austrian localities became Italian, to be incorporated into Yugoslavia after World War II. As a rule the official name of such localities changed with each change of nationality, so that they now are known under two or three different names. In many instances it proved to be impossible for me to ascertain the correct Yugoslav name of a locality, in which case only the German and/or Italian name has been cited.

that he observed the species once in a slightly lighted place), and is found at rocky places in subterranean streams, especially at the curves where the current is very slight or nil; it also has been met with in isolated stagnant pools, which at high water are connected with subterranean streams.

Biology. The animals are well adapted to subterranean life. They possess no pigment, not even in the eyes, which are degenerated and lack optical elements (MÜLLER, 1931, mentioned the presence of a tiny pigment spot in the anterior part of the eye of a very few of his specimens). The body is entirely transparent, only the contents of the intestinal tract may indicate the presence of the animal in the water. The integument is thin. The animals are photophobic. They are described as swimming slowly, but fleeing with sudden backwards directed movements when alarmed (WICHMANN, 1926). They may be collected by hand if care is taken that the water is not disturbed. JOSEPH (1881, p. 276) reports that the females are ovigerous between the end of April and June; some data on the development have been given by MÜLLER (1931) and STAMMER (1932). STAMMER (1933, 1935, 1935a) mentioned two epibionts of *Troglocaris*, namely the suctorian *Spelaeophrya troglocaridis* Stammer living on the antennae, and a temnocephalan *Scutariella didactyla* Mrazek found on the gills. According to KOLLAR (1848) *Troglocaris* forms the main food of *Proteus anguinus freyeri* (Fitzinger), while also FREYER (1849) and JOSEPH (1881, p. 246) make mention of the fact that *Troglocaris* is eaten by *Proteus*.

Troglocaris anophthalmus planinensis Birstein, 1948.

Troglocaris schmidti planinensis BIRSTEIN, 1948, p. 5, fig. 2; JUSBASCHJAN, 1951, p. 505.

Distribution. Type locality : Cave near Planina, N.-E. of Postojna (= Postumia, = Adelsberg), Carniola, Yugoslavia (BIRSTEIN, 1948).

This form strongly resembles the typical *Troglocaris anophthalmus*, while it was found in the centre of the range of that form. It is possible therefore that the two forms cannot be kept separate.

Troglocaris anophthalmus intermedia Babić, 1922.

Troglocaris schmidti intermedia BABIĆ, 1922, p. 300, fig. 1-4; WOLF, 1934, p. 101; BIRSTEIN, 1948, p. 5, 7, 8; JUSBASCHJAN, 1951, p. 505.

Troglocaris schmidtii intermedia SPANDL, 1926, p. 92, fig. 62.

Troglocaris Schmidti intermedia CHAPPUIS, 1927, p. 89, fig. 50; MÜLLER, 1931, p. 211; FAGE, 1937, p. 222, 224, 225, 226; JEANNEL, 1943, p. 269, fig. 114.

Troglocharis Schmidti JEANNEL, 1950, p. 49, fig. 5.

Distribution. Type locality : Mikašinović's Cave near Gornje Dubrave, 6 km from Ogulin, Croatia, Yugoslavia (BABIĆ, 1922). It is possible that the specimens reported as *Troglocaris schmidti* from the Vjetrenica Cave near Zavala, Hercegovina by STAMMER (1935, 1935a) and from Popovopolje, Hercegovina, by *Beatty* (1949) actually belong here.

Ecology. Found in clear fresh subterranean water with a temperature of 11° C. and a bottom of fine sand; depth of the water about 0.5 m.

Biology. The animals are without any pigment and have the body transparent. They swim quite well and are hard to catch as they flee at the slightest provocation.

Several authors consider it impossible to separate this form from the typical subspecies.

Troglocaris hercegovinensis (BABIĆ, 1922).

Troglocaridella hercegovinensis BABIĆ, 1922, p. 303, fig. 5; MÜLLER, 1931, p. 210, 211 ; BIRSTEIN, 1933, p. 150 ; WOLF, 1934, p. 102 ; FAGE, 1937, p. 222, 224, 226; WOLTERECK, 1937, p. 325 ; CHACE, 1943, p. 26; JEANNEL, 1943, p. 269; HOLTHUIS, 1955, p. 21.

Troglocaris hercegovinensis BABIĆ, 1922, p. 304; SPANDL, 1926, p. 94; FAGE, 1937, p. 225.

Troglocaridinella hercegovinensis SPANDL, 1926, p. 94, 141, 145, 181, 189, fig. 61.

Troglocaridella hercegovensis CHAPPUIS, 1927, p. 90.

Troglocaridella hercegoviniensis STAMMER, 1932, p. 607.

Troglocaridella herzogoviniensis STAMMER, 1933, p. 265.

Troglocaris schmidti p.p. KARAMAN, 1935, p. 63.

Troglocaridella herzegowiniensis STAMMER, 1935, p. 95.

Troglocaris herzegowiniensis STAMMER, 1935, p. 95.

Troglocaris Schmidti Schmidti forma *hercegovinensis* FAGE, 1937, p. 226, fig. 7.

Troglocaris schmidti hercegovinensis BIRSTEIN, 1948, p. 5, 6, 7; JUSBASCHJAN, 1951, p. 504,505 fig. 9^{III}.

Distribution. Type locality : Vjeternica Cave near Zavala, Hercegovina, Yugoslavia (BABIĆ, 1922; STAMMER, 1933, 1935; FAGE, 1937).

The systematic position of this form has been the subject of much dispute. BABIĆ formed a new genus on it, while other authors considered it congeneric (some even conspecific) with *Troglocaris anophthal-*

mus. I agree with STAMMER (1935) that the difference in the shape of the male pleopods of this species and those of *Troglocaris anophthalmus* justify the specific separation of the two, the more so as both forms occur together in the Vjeternica Cave. It seems improbable to me that we have to do here with dimorphic males.

Troglocaris kustaisiana kutaissiana (Sadovsky, 1930).

Xiphocaridinella kutaissiana SADOVSKY, 1930, p. 95; HOLTHUIS, 1955, p. 21.

Troglocaris schmidtii kutaissiana BIRSTEIN, 1933, p. 149, fig. 19-24; BIRSTEIN et VINOGRADOV, 1934, p. 42 ; JUSBASCHJAN, 1934, p. 189-193 ; WOLTERECK, 1937, p. 327.

Troglocaris schmidti kutaissiana WOLF, 1934, p. 102; WOLF, 1937, p. 769; BIRSTEIN, 1939, p. 962; SHADIN, 1940, p. 803; BIRSTEIN, 1941, p. 424, fig. 223[6]; BIRSTEIN, 1948, p. 4, 7; BIRSTEIN, 1950, p. 356.

Troglocaris Schmidti kutaissiana FAGE, 1937, p. 222, 226, fig. 8; JEANNEL, 1943, p. 270.

Troglocaridinella kutaissiana WOLTERECK, 1937, p. 327.

Troglocaris kutaissiana JUSBASCHJAN, 1940a, p. 153-172, fig.; JUSBASCHJAN, 1940b, p. ???; JUSBASCHJAN, 1940c, p. ???; JUSBASCHJAN, 1941, p. 929 ; JUSBASCHJAN, 1942, p. 161 ; JUSBASCHJAN, 1947, p. 245-254; BIRSTEIN, 1948, p. 4.

Troglocaris kutaissiana kutaissiana JUSBASCHJAN, 1951, p. 505, fig. 1, 3, 5, 6, 9IV, 10-13.

Distribution. Only found in the region of Kutais in the western Transkaukasus, Georgia, U.S.S.R. Type locality : Rion Cave near Kutais (SADOVSKY, 1930; BIRSTEIN, 1933; BIRSTEIN et VINOGRADOV, 1934). Additional locality : Cave near the shore of the Zchal-Ziteli River near Kutais (BIRSTEIN, 1933; BIRSTEIN et VINOGRADOV, 1934). I have not been able to consult most of JUSBASCHJAN'S publications dealing with this animal, so that it may be known from more stations; that these do not lie outside the Kutais region is shown by the fact that JUSBASCHJAN in 1951 mentioned this subspecies as occurring in that region only.

I follow JUSBASCHJAN (1951) in considering *Troglocaris anophthalmus* and *T. kutaissiana* as distinct species.

Troglocaris kutaissiana ablaskiri Birstein, 1939.

Troglocaris schmidti ablaskiri BIRSTEIN, 1939, p. 961, fig. 1, 2; BIRSTEIN, 1948, p. 7, 8; BIRSTEIN, 1950, p. 356.

Troglocaris kutaissiana ablaskiri JUSBASCHJAN, 1951, p. 505, fig. 9v.

Distribution. Type locality : Subterranean river in Achkhshe-tyzgua Cave and a nameless cave near the village of Atap in Abkhazia, western Transcaucasia, Georgia, U.S.S.R. (BIRSTEIN, 1939).

Troglocaris kutaissiana fagei Birstein, 1939.

Troglocaris schmidti fagei BIRSTEIN, 1939, p. 964, fig. 3-5; BIRSTEIN, 1948, p. 4, 7; BIRSTEIN, 1950, p. 356.

Troglocaris kutaissiana fagei JUSBASCHJAN, 1951, p. 505, fig. 8.

Distribution. Type locality : Subterranean freshwater lake near Psyrztkha, Abkhazia, western Transcaucasia, Georgia, U.S.S.R. (BIRSTEIN, 1939).

BIRSTEIN (1939) described larval stages of this form.

Troglocaris kutaissiana jusbaschjani Birstein, 1948.

Troglocaris schmidti jusbaschjani BIRSTEIN, 1948, p. 4, fig. 1.

Troglocaris schmidti jusbaschiani JUSBASCHJAN, 1951, p. 504.

Troglocaris kutaissiana jusbaschiani JUSBASCHJAN, 1951, p. 505.

Distribution. Type locality : Subterranean waters near Mazesta, western Transcaucasia, Georgia, U.S.S.R. (BIRSTEIN, 1948).

Troglocaris kutaissiana osterloffi Jusbaschjan, 1940.

Troglocaris kutaissiana osterloffi JUSBASCHJAN, 1940, p. 73-86; JUSBASCHJAN, 1951, p. 505, fig. 7.

Troglocaris schmidti osterloffi BIRSTEIN, 1948, p. 7, 8; BIRSTEIN, 1950, p. 356.

Distribution. Type locality : Cave at Lower Shakuran near Zebelda, Suchumi district, Abkhazia, western Transcaucasia, Georgia, U. S. S. R. (JUSBASCHJAN, 1940).

PALAEMONIAS Hay, 1901.

The genus contains only one species :

Palaemonias ganteri Hay, 1901.

Palaemonias ganteri HAY, 1901, p. 180; HAY, 1903 *a*, p. 226, fig. *a-k*; CALMAN, 1909, p. 93; KEMP, 1912, p. 115; ORTMANN, 1918, p. 845, fig. 1311; SPANDL, 1926, p. 94, 141, 181; WOLF, 1934, p. 102; EDMONDSON,

1935, p. 15; WOLTERECK, 1937, p. 327; CHACE, 1943, p. 30, 32; JUSBASCHJAN, 1951, p. 503, fig. 4; PENNAK, 1953, p. 458 466; CHACE, 1954, p. 323; HOLTHUIS, 1955, p. 25, fig. 8 *b*.

Palaemonias Ganteri BOUVIER, 1925, p. 74, fig. 120-127; CHAPPUIS, 1927, p. 89, 152; FAGE, 1931, p. 362, fig. 1-21; FAGE, 1932, p. 646; JEANNEL, 1943, p. 271; HOLTHUIS, 1955, p. 24; ROTH-WOLTERECK, 1955, p. 197, 198.

Palaemonies ganteri GIOVANNOLI, 1933, p. 620.

Crevettes JEANNEL, 1950, p. 59.

Distribution. The species is only known from the Mammoth Cave, Kentucky, U. S. A. Type locality : Roaring River passage, Mammoth Cave (HAY, 1903 *a*; BOUVIER, 1925; GIOVANNOLI, 1933). Additional localities : Pools left by the Styx River (FAGE, 1931), pool near the Dead Sea, Mammoth Cave (GIOVANNOLI, 1933).

Ecology. The animals were found in clear subterranean freshwater pools, which with high water form part of a stream.

Biology. The species, like those of the genus *Troglocaris*, does not possess any pigment at all and is transparent, but according to JEANNEL (1950, p. 59) the transparency of this species is far less complete than that of *Troglocaris anophthalmus*. The eyes are degenerated. The integument is thin. According to HAY the animals are usually resting quietly or are slowly walking on the bottom of the pools. When disturbed they swim rapidly to the surface, from where, after a short time, they let themselves sink again to the bottom. They do not react to light and are rather easily caught with a net or even by bringing a hand very quietly under them, and raising it calmly to the surface. An ovigerous female was found in August. The species is « supposed to be the chief article of food for the crayfish and blind fishes » (GIOVANNOLI, 1933).

ANTECARIDINA Edmondson, 1954.

Of this genus only one species is known :

Antecaridina lauensis (Edmonson, 1935).

Mesocaris lauensis EDMONDSON, 1935, p. 13, fig. 4; EDMONDSON, 1935 *a*, p. 4; WOLTERECK, 1937, p. 327; HOLTHUIS, 1955, p. 25.

Antecaridina lauensis HOLTHUIS, 1955, p. 25, fig. 8 *d-f*.

Distribution. The species is known only from the Lau Islands, Fiji group, Polynesia. Type localities : Numbu Cave, Namuka Island (EDMONDSON, 1935, 1935 *a*), salty lake, Wangava Island (EDMONDSON, 1935, 1935 *a*). The former of these two localities is selected here as the restricted type locality.

Ecology. The animals from Namuka Island were found in large numbers in a brackish pool in a cave, the temperature of the water being 23.1° C. The other specimens were collected in a salty lake, which is fully exposed to the sunlight, and probably is connected with the sea by subterranean channels.

Biology. The species is of a bright red colour when alive. The eyes possess dark pigment, but the cornea is strongly reduced.

TYPHLATYA Creaser, 1936.

The present genus contains three species, all of which are troglobic forms, which inhabit the West Indian region.

Typhlatya pearsei Creaser, 1936.

Typhlatya pearsei CREASER, 1936, p. 128, fig. 31-41; CREASER, 1938, p. 162; CHACE, 1942, p. 100; CHACE, 1943, p. 30, 32; CARDENAS FIGUEROA, 1950, p. 156; RIOJA; 1953, p. 286, 292, 293 (as *T. pearsi*); CHACE, 1954, p. 319, 323; HOLTHUIS, 1955, p. 26, fig. 8 *g*.

Distribution. Found in caves in Yucatan, Mexico. Type locality : Balaam Canche Cave, 4.8 km E., 0.8 km S. of Chichen Itza, Yucatan (CREASER, 1936, 1938). Additional localities : Santa Elena Cave, 4.8 km S of Talcha, Yucatan (CREASER, 1936, 1938), Hoctun Cave at Hoctun and El Pochote Cave, Yucatan (CARDENAS FIGUEROA, 1950).

Ecology. In fresh water of caves. In the two caves in which the species was collected the temperature of the water was 23°8 and 25°8 C respectively, the *p*H 7.4 and 6.8, while it contained 4.56 cc and 0.57 cc O_2 per liter and 0.05 g and 0.22 g NaCl per liter respectively.

Biology. Body without any pigment. The eyes strongly degenerated, likewise without pigment.

Typhlatya garciai Chace, 1942.

Typhlatya garciai CHACE, 1942, p. 99, pl. 29; CHACE, 1943, p. 30, 32; CHACE, 1954, p. 319, 323.

Distribution. Type locality : Potrero del Molino Cave, Las Cuatrocientas Rosas, Banes, Oriente Province, Cuba (CHACE, 1942).

Ecology. The animals live in fresh water in total darkness.

Biology. The species is entirely colourless, except for a tiny pigment spot on the degenerated eye. With the brushy tips of their chelae the animals « scrub the surface of the stones or roots that are in the water, apparently feeding upon this substance ». In captivity they accept bread crumbs evidently using them as food, but they do not eat live food.

Typhlatya monae Chace, 1954.

Typhlatya monae CHACE, 1954, p. 318, fig. 1.

Distribution. The species has only been found in Mona Island, Puerto Rico, West Indies. Type locality : Well near « El Molino » about 1 mile S.-E. of the N.-Y.-A. camp at Sardinera, Mona Island (CHACE, 1954). Additional locality : Concrete water catchment basin on high plateau of Mona Island (CHACE, 1954).

Ecology. Apart from being found in a well with a depth of 30 feet, the species was met with also in a partrly covered concrete water catchment basin which apparently has no connection with subterranean waters.

Biology. The eyes are strongly reduced, but possess a small pigment spot.

TYPHLOPATSA new genus.

Definition. Carapace without supra-orbital and pterygostomian spines. Antennal spine placed on the lower orbital angle and merged with it. Eyes strongly reduced and bullet-shaped, without any pigment. Second maxilliped without podobranch. A single arthrobranch is present on the third maxilliped, while each of the pereiopods possesses one distinct pleurobranch. No arthrobranch at the base of the first leg. The first three pereiopods are provided with epipods, while well developed exopods are present on all the legs. The chelae have the fingers less than twice as long as the palm and provided with tufts of hairs at their tips. The carpi of both the first and the second pair of pereiopods are deeply excavate anteriorly. The diaeresis of the uropodal exopod bears no spinules.

This new genus is most closely related to the genera *Typhlatya* Creaser and *Antecaridina* Edmondson. From the former genus it may immediately be distinguished by the presence of an antennal spine and by the absence of an epipod on the fourth pereiopod. From *Antecaridina* it differs by the entirely different shape of the eyes, by the absence of a pterygostomian spine and by the absence of the epipod on the fourth pereiopod.

The type and only species of the present genus is :

Typhlopatsa pauliani new species.

Material examined : Mitoho Cave, N.-E. corner of Tsimanampetsotsa Lake, Mahafaly Province, S.-W. Madagascar, May 1951, R. PAULIAN. — 26 specimens, 4-13 mm long.

Definition. The rostrum is short, pointed and directed forwards or slightly upwards. It fails to reach the end of the eyes and also is over-reached by the antennal spines. No teeth are present on either margin

The pleurae of the fifth abdominal segment are rounded. The sixth abdominal segment is longer than the telson. The latter possesses two pairs of dorsal and five pairs of posterior spines.

Ecology. From a rather large subterranean freshwater pool of more than 2 m deep, in which blind fishes and blind Cirolanids live together with Tanaidacea which are provided with eyes.

The generic name refers to the blindness of the animals and to the vernacular name « patsa » which in Madagascar is used for small Atyids. It is a pleasure to dedicate this interesting species to Dr. R. PAULIAN, directeur-adjoint of the Institut Scientifique de Madagascar, who was so kind to place this valuable material, which was collected by himself, at my disposal.

PARISIA new genus.

Definition. Carapace without supra-orbital or pterygostomian spines; antennal spine present, sometimes merged with the lower orbital angle. Eyes sometimes reduced, though then still with a small pigment spot. Second maxilliped with a vestigial podobranch. Third maxilliped with a distinct arthrobranch and sometimes with rudiments of a second. Each of the pereiopods with a single pleurobranch. No arthrobranch at the base of the first pereiopod. Exopods absent from all the pereiopods, but epipods on the first four pairs. Chelae of the first two pereiopods with the fingers less than twice as long as the palm and provided with tufts of hairs at their tips. Carpus of first leg deeply excavated anteriorly, that of the second leg hardly so. Exopod of uropods with a row of spinules placed on the diaeresis.

Parisia is most closely related to *Caridella* Calman, but differs from that genus in the branchial formula and in the shape of the eyes. The new genus also strongly resembles *Caridina* H. Milne Edw. from which it at once is distinguished by the absence of the arthrobranch of the first pereiopod. The type species of the present genus is *Caridina microphthalma* Fage, 1946, dealt with below. Two more species of this genus have been found in subterranean waters of Madagascar, these two species proved to be new to science.

The present new genus is dedicated to Dr BRUNO PARISI, the well known carcinologist of the Milan Museum, who counts amongst his carcinological discoveries that of the first species of subterranean shrimp *(Typhlocaris lethaea)* to become known from Africa.

Parisia microphthalma (Fage, 1946).

Caridina microphthalma FAGE, 1946, p. 324, fig. 1, 2.

The absence of the arthrobranch from the base of the first pereiopod shows that the present species cannot be maintained in the genus *Caridina* H. Milne Edwards.

Distribution. Type locality : Grotte des Fanihy, Ankarana Mts., N. of Ambilobé, N.-W. Madagascar (FAGE, 1946). A specimen collected by Dr R. PAULIAN in April 1951 at the type locality could be examined.

Ecology. FAGE's specimens were found in a subterranean freshwater rivulet, that collected by Dr PAULIAN in a lake of about 10 m long and 2 or 3 m deep which is situated in total darkness.

Biology. The eyes are strongly reduced and provided with a tiny pigment spot only.

Parisia edentata new species.

Material examined : Southern part of Antsingy Mts., near Bekopaka, Mahilaka Province, W. Madagascar; in a very dark deep well under rocks; July 1949, leg. R. PAULIAN. — 13 specimens, 5-16 mm long.

Definition. The rostrum is short, rather high, and pointed, reaching slightly beyond the eyes, and having neither dorsal nor ventral teeth. Lower orbital angle acute and merged with the antennal spine. Fifth abdominal segment with the apex of the pleurae rectangular. Telson with four pairs of dorsal and five pairs of posterior spines. Eyes strongly reduced, with a tiny pigment spot. First pereiopod with the carpus much shorter than in *Parisia microphthalma*, being somewhat less than twice as long as high.

Nothing is known about the biology of the species, apart from the fact that the eyes are strongly reduced.

Parisia macrophthalma new species.

Material examined : Grotte des Fanihy, Ankarana Mts., N. of Ambilobé, N.-W. Madagascar, in a subterranean lake, about 10 m long and 2 or 3 m deep, in total darkness, April 1951, leg. R. PAULIAN. — 30 specimens, 17-21 mm long.

Definition. The rostrum reaches about to the end of the antennular peduncle; the upper margin bears 17-27 spinules and teeth, the lower margin 2-5 teeth. The lower orbital angle is distinctly separated from the antennal spine. Fifth abdominal segment with the pleura bluntly pointed. Telson with three or four pairs of dorsal and five pairs of posterior spines. Eyes normally developed. The first pereiopod has the carpus slightly longer than that of *P. edentata*, but distinctly shorter than in *P. microphthalma*.

CARIDINOPSIS Bouvier, 1912.

Of this genus until now only one species was known; it occurs in surface waters in West Africa. The following new species was found in a cave.

Caridinopsis brevinaris new species.

Material examined : Garrigues Cave near Souguéta, French Guinea, April 6, 1954, leg. A. VILLIERS. — 17 specimens.

Definition. The rostrum fails to reach the end of the second segment of the antennular peduncle, it is straight with the lower margin unarmed or provided with a single tooth. The distal part of the upper margin of the rostrum is unarmed, in the proximal part three to five teeth are present, one to three of which are placed before the posterior limit of the orbit. There are considerable interspaces between the teeth, which are not placed so close together as in *Caridinopsis chevalieri* Bouvier. The stylocerite distinctly fails to reach the end the basal segment of the antennular peduncle. The lamella of the scaphocerite reaches far beyond the final tooth. The pereiopods are similar to those of *C. chevalieri.*

Ecology. The species was found in a subterranean rivulet.

Biology. The eyes are well developed and do not differ from those of *C. chevalieri.*

CARIDINA H. Milne Edwards, 1837.

This genus contains a very large number of species, only one of which inhabits subterranean waters.

Caridina lovoensis Roth-Woltereck, 1955.

Caridina lovoensis Roth-Woltereck, 1955, p. 197, fig. 1, 2.

Distribution. Type locality : Caves of Lovo, 20 km from Thysville, Bas-Congo, Belgian Congo (ROTH-WOLTERECK, 1955).

Ecology. Found in fresh water of a limestone cave.

Biology. The eyes are reduced.

FAMILY PALAEMONIDAE

SUBFAMILY PALAEMONINAE

CREASERIA Holthuis, 1950.

This genus contains only one species.

Creaseria morleyi (Creaser, 1936).

Palaemon morleyi CREASER, 1936, p. 126, fig. 25-30; CREASER, 1938, p. 163; CHACE, 1943, p. 31, 33; CARDENAS FIGUEROA, 1950, p. 156; RIOJA, 1953, p. 286 (P. *morley*), 293, 294; HOLTHUIS, 1955, p. 44.

Creaseria morleyi HOLTHUIS, 1950, p. 6; HOLTHUIS, 1952, p. 153, pl. 40; CHACE, 1954, p. 323; HOLTHUIS, 1955, p. 45, fig. 22 *a*.

Distribution. *Creaseria morleyi* until now has only been found in caves in Yucatan, Mexico. Type locality : San Isidro Cave, Salar Colony, Merida, Yucatan (CREASER, 1936, 1938). Additional localities : San Bulha Cave, Motul, Yucatan (CREASER, 1936, 1938), Amil Cave on Tixcacal Hacienda, 14 km S.-E., 2 km E. of Merida, and Balaam Canche Cave, 4.8 km E., 0.8 km S. of Chichen Itza, Yucatan (CREASER, 1936, 1938; HOLTHUIS, 1952), Chac Mol Cave near Tohil, Yunchen Cave at Libre Union, Gongora Cave at Oxkutzcab, and Spukil Cave at Calcehtok, Yucatan (CREASER, 1938), Hoctun Cave at Hoctun, Yucatan (CREASER, 1938; CARDENAS FIGUEROA, 1950), El Pochote Cave, Yucatan (CARDENAS FIGUEROA, 1950), ? Xconsacab Cave, Tizamin, Yucatan (CREASER, 1938).

Ecology. The species lives in fresh subterranean waters. The temperature of the water of some of the caves varied between 23°8 and 26°8 C., the *p*H between 6.8 and 7.4, the contents of dissolved oxygen between 0.57 and 4.56 cc per liter, the salinity between 0.05 and 0.33 grams NaCl per liter.

Biology. The animals are entirely colourless, the eyes are unpigmented and degenerated. They « were observed crawling about on the bottom », but are « swift swimmers and are extremely sensitive to vibrations in the water » (CREASER, 1936). They are attracted by meat and are collected in traps with meat as bait. Their stomachs contained chitinous parts including one small claw of their own species (CREASER, 1938).

PALAEMONETES Heller, 1869.

This genus is divided into two subgenera, one of which, *Alaocaris* Holthuis, 1949, is confined to subterranean waters. The typical subgenus contains numerous species living in salt, brackish and fresh waters, only one of these species being troglobic.

Palaemonetes (Palaemonetes) cummingi Chace, 1954.

Palaemonetes (Palaemonetes) cummingi CHACE, 1954, p. 319, fig. 2.

Distribution. Type locality : Squirrel Chimney, Alachua County, Florida, U. S. A. (CHACE, 1954).

Ecology. Found in a fissure with subterranean fresh water; part of this body of water was dimly lighted, part was in total darkness. The bottom consisted of « mud, sand, and silt, with large limerock outcrops ».

Biology. The eyes are degenerated and have no pigment; the cornea, though small, still is visible. The body is completely translucent

and colourless, with only some organs shining through. The animals were found to be sensitive to light. They were observed to swim freely in the water, and in an aquarium were frequently seen resting on the bottom or hanging on other objects. In captivity they readily accepted liver as food.

Palaemonetes (Alaocaris) antrorum Benedict 1896.

Palaemonetes antrorum Benedict, 1896, p. 615; Kingsley, 1899, p. 718; Eigenmann, 1900, p. 228, 230; Neher, 1902, p. 96, fig. 2-7; Ulrich, 1902, p. 93, pl. 17; Calman, 1909, p. 93; Uhlenhuth, 1921, p. 75, 76, 79, 85, 90, 96, 101; Kemp, 1925, p. 317; Spandl, 1926, p. 90, 141; Chappuis, 1927, p. 87, 150; Chace, 1943, p. 31, 34; Mohr, 1948, p. 17; Pennak, 1953, p. 458, 466; Holthuis, 1955, p. 51.

Palaemonetes antorum Mohr, 1948 *a*, p. 109.

Palaemonetes (Alaocaris) antrorum Holthuis, 1949, p. 89, fig. 1 *a-e*; Holthuis, 1950, p. 11; Holthuis, 1952, p. 203, pl. 49, 50, 51, fig. *a-d*; Chace, 1954, p. 323; Holthuis, 1955, p. 49, fig. 26.

Distribution. The species has been found only in subterranean water near San Marcos, Texas, U. S. A. Type locality : Artesian well of the U. S. Fish Hatchery at San Marcos, Texas (Benedict, 1896; Eigenmann, 1900; Neher, 1902; Ulrich, 1902; Uhlenhuth, 1921; Holthuis, 1952). Additional localities : Ezell's Cave near San Marcos (Uhlenhuth, 1921; Mohr, 1948, 1948 *a*; Holthuis, 1952), well in Beaver Cave near San Marcos (Uhlenhuth, 1921; Mohr, 1948 *a*), well of Frank Johnson Farm near San Marcos (Uhlenhuth, 1921; Mohr, 1948 *a*).

Ecology. The animals live in pure fresh water of subterranean origin, with a temperature of about 21°5 C. The type locality is an artesian well of 188 feet deep. Mohr (1948) reported the species from a shallow subterranean pool. Uhlenhuth (1921) observed it in a subterranean pond formed by an extremely slow flowing river.

Biology. The body is perfectly transparent, the eyes are degenerated and show no pigment or lens structures. The animals were observed swimming near the surface of the water. They probably breed in the summer or late spring.

TROGLOCUBANUS Holthuis, 1949.

The genus contains four species, all four of which inhabit subterranean waters of the island of Cuba.

Troglocubanus calcis (Rathbun, 1912).

Palaemonetes calcis RATHBUN, 1912, p. 451, pl. 1, fig. 1-3, 5; KEMP, 1925, p. 317; SPANDL, 1926, p. 90, 141; CHAPPUIS, 1927, p. 87; WOLF, 1934, p. 103; CHACE, 1943, p. 25, 27, 28, 29, 31, 34, pl. 5; HOLTHUIS, 1949, p. 91.

Troglocubanus calcis HOLTHUIS, 1950, p. 11; HOLTHUIS, 1952, p. 144, pl. 36; CHACE, 1954, p. 323.

Distribution. Type locality : Pool in a cave between Madruga and Aguacate, Havana Province, Cuba (RATHBUN, 1912; CHACE, 1943; HOLTHUIS, 1952).

Ecology. Found in a freshwater pool of a limestone cave.

Biology. The eyes are degenerated and possess no pigment. The animals were « usually seen swimming slowly about in the water at some distance from the bottom » (RATHBUN, 1912).

Troglocubanus eigenmanni (Hay, 1903).

Palaemonetes eigenmanni HAY, 1903, p. 431, fig. 2; CALMAN, 1909, p. 93; EIGENMANN, 1909, p. 202; RATHBUN, 1912, p. 453; KEMP, 1924, p. 46; KEMP, 1925, p. 317; SPANDL, 1926, p. 90, 141 ; WOLF, 1934, p. 103; CHACE, 1943, p. 31, 34; BARBOUR, 1945, p. 192, 199; HOLTHUIS, 1949, p. 91; HOLTHUIS, 1955, p. 51.

Palaemonetes eigenmani PIKE, 1906, p. 267, fig. 1-7.

Palaemonetes Eigenmanni CHAPPUIS, 1927, p. 87, 150.

Troglocubanus eigenmanni HOLTHUIS, 1950, p. 11; HOLTHUIS, 1952, p. 146, pl. 37; CHACE, 1954, p. 324.

Distribution. The species is known from caves in Pinar del Rio, Havana and Matanzas Provinces, Cuba. Type locality : Cave near Ashton, S.-W. of Alquizar, Pinar del Rio Province (HAY, 1903; RATHBUN, 1912; HOLTHUIS, 1952). Additional localities : Caves at Modesta, Jaiguan and San Isidro, near Cañas, Pinar del Rio Province (HAY, 1903), caves near Cañas, Pinar del Rio Province (PIKE, 1906), cave near San Cristobal, Pinar del Rio Province (HOLTHUIS, 1952), cave near Güira de Melena, Havana Province (RATHBUN, 1912; HOLTHUIS, 1952), cave near Alacranes, Matanzas Province (CHACE, 1943), cave near Unión de Reyes (? = Alacranes), Matanzas Province (BARBOUR, 1945).

Ecology. Found in subterranean fresh water.

Biology. The body possesses no pigment; the eyes are degenerated and have no pigment either. The species « is essentially pelagic in habit, though it is frequently seen resting on various objects on the bottom » (EIGENMANN, 1909).

Troglocubanus gibarensis (Chace, 1943).

Palaemonetes gibarensis CHACE, 1943, p. 28, pl. 7; HOLTHUIS, 1949, p. 91.

Troglocubanus gibarensis HOLTHUIS, 1950, p. 11; HOLTHUIS, 1952, p. 149, pl. 38; CHACE, 1954, p. 323; HOLTHUIS, 1955, p. 50, fig. 27 *a*.

Distribution. Type locality : Aguada del Montañes, El Jobal, Barrio de Cupeysillo, Termino de Gibara, Oriente Province, E. Cuba (CHACE, 1943).

Ecology. From a freshwater well with a depth of 29 yards.

Biology. The body lacks pigment; the eyes are degenerated and have no pigment either. The animals are « live-feeders, taking mosquito larvae quite voraciously but discarding bread crumbs after sampling them » (CHACE, 1943).

Troglocubanus inermis (Chace, 1943).

Palaemonetes calcis p. p. RATHBUN, 1912, p. 451, pl. 1, fig. 4.

Palaemonetes inermis CHACE, 1943, p. 26, pl. 6; HOLTHUIS, 1949, p. 91.

Troglocubanus inermis HOLTHUIS, 1950, p. 11; HOLTHUIS, 1952, p. 150, pl. 39; CHACE, 1954, p. 323.

Distribution. Type locality : Pool in a cave between Madruga and Aguacate, Havana Province, Cuba (RATHBUN, 1912; CHACE, 1943; HOLTHUIS, 1952).

Biology. The eyes are degenerated and without pigment.

MACROBRACHIUM Bate, 1868.

The genus *Macrobrachium* contains numerous species which inhabit fresh or brackish waters, while some may be found in the sea. Though severae of the species have been met with in caves, only one can be considered to be a true troglobic species.

Macrobrachium cavernicola (Kemp, 1924).

Palaemon cavernicola KEMP, 1924, p. 42, pl. 3 fig. 1-4; KEMP et CHOPRA, 1924, p. 11, 12, 18, 19, 20; SPANDL, 1926, p. 89, 140, 141, fig. 59, 104, 106; CHAPPUIS, 1927, p. 87, 118, 119, fig. 49, 64, 66; WOLF, 1934, p. 102; JEANNEL, 1943, p. 267.

Macrobrachium cavernicolum CHACE, 1943, p. 26.

Macrobrachium cavernicola HOLTHUIS, 1950, p. 13, 109, 205.

Distribution. Until now found only in caves in Assam, India. Type locality : Siju Cave, Garo Hills, Assam (KEMP, 1924; KEMP et CHOPRA, 1924). Additional locality : Cave near Cherrapundji, Assam, February 2, 1947, coll. K. LINDBERG.

Ecology. KEMP (1924) reports his animals from small freshwater streams and pools situated in total darkness at 165 to 1200 m from the entrance of a cave; at periods of high water the pools probably are connected with the streams. The specimens from Cherrapundji, which Dr. K. LINDBERG, Lund, Sweden, kindly allowed me to examine, were found in fresh water at about 300 m from the entrance of a cave.

Biology. The colour of the live animals is semi-translucent white with minute red chromatophores. The eyes have the cornea strongly reduced, but still provided with pigment and optic elements. The animals are slightly attracted by light. The species was observed feeding on dead animals. One specimen was found on a mud covered rock, about 2 feet above the water level; tracks in the mud showed that this had happened more than once. The significance of this most unusual fact is not known.

SUBFAMILY TYPHLOCARIDINAE

TYPHLOCARIS Calman, 1909.

The genus contains three species all of which are troglobic, they have been found in localities around the eastern part of the Mediterranean.

Typhlocaris galilea Calman, 1909.

Typhlocaris galilea CALMAN, 1909, p. 93, 94, pl. 19; ANNANDALE, 1912, p. 251; ANNANDALE et KEMP, 1913, p. 245, textfig. A, B, pl. 12, 13; GHOSH, 1913, p.233, pl. 15, 16; p.p.PARISI, 1920, p.104; COLOSI, 1921, p.2; PARISI, 1921, p. 241, 243, 246; CAROLI, 1923, p. 265; CAROLI, 1923 *a*, p. 40; COLOSI, 1923, p. 6; CAROLI, 1924, p. 1, 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15; CAROLI, 1925, p. 372; SPANDL, 1926, p. 91, 93, 181, 189, fig. 60, 61; STAMMER, 1933, p. 265; WOLF, 1934, p. 103; BODENHEIMER, 1935, p. 412, 419, 439, 442, pl. 61, fig. 3; CHACE 1943, p. 26; HOLTHUIS, 1950, p.2; HOLTHUIS, 1955, p. 75, fig, 49.

Typhlocaris galilaea CHAPPUIS, 1927, p. 86, fig. 48; CRAIG-BENNETT, 1938, p. 797; JEANNEL, 1943, p. 268, fig. 113.

Thyphlocaris Galilea BOTTAZZI, de LORENZIS ET STASI, 1923, p. 307; BOTTAZZI, 1924, p. 108.

Distribution. Subterranean water near the Sea of Galilee (= Lake of Tiberias), Israel. Type locality : Small pond near the town of Tiberias

(CALMAN, 1909 ; ? STAMMER, 1933). Additional localities : Birket Ali-ed-Dhaher, a pool at Et-Tabghah near Tiberias, probably the same as the type locality (ANNANDALE, 1912; ANNANDALE et KEMP, 1913; CAROLI, 1924), cistern of the water-mill near Tabghah at the north end of the Sea of Galilee (CRAIG-BENNETT, 1938).

Ecology. The species was observed in a small artificial pool containing from six to ten feet of brackish sulphurous water, fed by a subterranean spring. A large part of the surface of the water being concealed by a growth of long grass (ANNANDALE et KEMP, 1913).

Biology. The animals are of a uniform dead, somewhat opalescent, white without external pigmentation. The eyes are degenerated and possess no pigment and no optical elements. The species seems not to be sensitive to light. It is rather sluggish and generally stays close to the bottom, being often found under stones. With the aid of the pereiopods and the pleopods it moves forward, rapid backward movements are made when the animal is disturbed. Apart from the antennular and antennal flagella also the third maxillipeds and the first pereiopods are used for feeling. The first pereiopods furthermore serve for cleaning the other appendages and for picking up food and bringing it to the mouth. The animals were observed to feed on meat.

Typhlocaris lethaea Parisi, 1921.

Typhlocaris galilea p. p. PARISI, 1920, p. 101, fig.

Typhlocaris lethaea PARISI, 1921, p. 241, fig. 1-5; COLOSI, 1921, p. 1-2; COLOSI, 1923, p. 4, 6, 11; CAROLI, 1923, p. 265, 266; CAROLI, 1923 *a*, p. 40; CAROLI, 1924, p. 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, text-fig. 3 *b*, 6 *b*, pl. 2, fig. 10; CAROLI, 1925, p. 372; SPANDL, 1926, p. 91, 148, 181, 189, fig. 61; CHAPPUIS, 1927, p. 86; CALMAN, 1927, p. 54, fig. ; WOLF, 1934, p. 103 ; ZAVATTARI, 1934, p. 139 ; BODENHEIMER, 1935, p. 447 ; WOLF, 1937, p. 770 ; CHACE, 1943, p. 26 ; JEANNEL, 1943, p. 268; HOLTHUIS, 1950, p. 2.

Thyphlocaris Lethaea BOTTAZZI, de LORENZIS et STASI, 1923, p. 307, 308; BOTTAZZI, 1924, p. 108.

Distribution. Type locality : Grotta del Lete (= Giok-Kebir), at 10 km east of Bengasi, Lybia (PARISI, 1920, 1920 *a*; COLOSI, 1921, 1923; CAROLI, 1924; CALMAN, 1927). Additional locality : Cave 2 km from Grotta del Lete, near Bengasi, Lybia (CALMAN, 1927).

Ecology. Found in a clear subterranean lake in a cave, situated in a rocky limestone plain; the water being fresh in the wet season, salty in the dry period. CALMAN mentioned that the temperature of the water was 21° C. The species was observed both near the entrance of the cave where the darkness was not absolute and in the dark parts farther away from the entrance.

Biology. The animals are milky white, have degenerated eyes, and possess no pigment.

Typhlocaris salentina Caroli, 1923.

Typhlocaris salentina CAROLI, 1923, p. 265 ; CAROLI, 1923 *a*, p. 40; CAROLI, 1924, p. 1, text-fig. 1, 2, 3 *a*, 4, 5, 6 *a*, 7-10, pl. 2, fig. 1-9; CAROLI, 1925, p. 372; SPANDL, 1926, p. 91, 141, 145, 181, 189; CHAPPUIS, 1927, p. 87; WOLF, 1934, p. 103; BODENHEIMER, 1935, p. 442; WOLF, 1937, p. 770; CHACE, 1943, p. 26; JEANNEL, 1943, p. 268; HOLTHUIS, 1950, p. 2.

Thyphlocaris Salentina BOTTAZZI, de LORENZIS et STASI, 1923, p. 307, 308, fig. 5.

Typhlocaris Salentina BOTTAZZI, 1924, p. 108.

Distribution. Type locality : « La Zinzulusa » Cave near Otranto in the Salentina Peninsula, S.-E. Italy (CAROLI, 1923, 1923 *a*, 1924, 1925; BOTTAZZI, de LORENZIS et STASI, 1923; BOTTAZZI, 1924).

Ecology. Found in a pool with slightly brackish water in the dark part of a cave.

Biology. The eyes are almost entirely degenerated, but still show a tiny spot of pigment. The stomach contents of this species showed fragments of insect skeletons and lepidopteran scales; the shrimps probably feed on the excrements of the bats that inhabit the cave.

FAMILY HIPPOLYTIDAE

BARBOURIA Rathbun, 1912.

This genus contains but one species.

Barbouria cubensis (Von Martens, 1872).

Hippolyte Cubensis VON MARTENS, 1872, p. 136, pl. 5, fig. 14.

? *Hippolysmata cubensis* KINGSLEY, 1878, p. 89.

Hippolysmata cubensis KINGSLEY, 1878 *a*, p. 56.

Barbouria poeyi RATHBUN, 1912, p. 455, pl. 2-5; KEMP, 1924, p. 45; WOLF, 1934, p. 102; CHACE, 1943, p. 30, 33; BARBOUR, 1945, p. 194; RIOJA, 1953, p. 294 ; HOLTHUIS, 1955, p. 99.

Barbouria poegi SPANDL, 1926, p. 89.

Barbouria poey SPANDL, 1926, p. 140.

Barbouria Poeyi CHAPPUIS, 1927, p. 88, 90; JEANNEL, 1943, p. 267.

Barbouria cubensis HOLTHUIS, 1947 *a*, p. 7, 33; CHACE, 1954, p. 323; HOLTHUIS, 1955, p. 99, fig. 67.

Distribution. Type locality : Cuba (VON MARTENS, 1872). Additional locality : Cave near the seashore between Morro Castle and Cojimar,

Cuba (RATHBUN, 1912; BARBOUR, 1945). Since VON MARTENS's specimens in all probability came from the same cave as those described by RATHBUN, the additional locality cited above may be considered to be the restricted type locality.

Ecology. The species was found in clear, slightly brackish water in a cave; the water level fluctuated with each tide and it is most probable that a subterranean connection between the cave and the sea existed.

Biology. The body of the living animal is of a translucent crimson colour (except for the antennae and first pereiopods, which are pure white). The eyes are well developed and provided with dark pigment.

II. LIST OF DECAPODA NATANTIA FOUND INCIDENTALLY IN SUBTERRANEAN WATERS

As far as is known to me the species belonging in this category form part of three families, viz., the *Penaeidae*, the *Atyidae*, and the *Palaemonidae*.

FAMILY PENAEIDAE

PENAEUS Fabricius, 1798.

Penaeus indicus H. Milne Edwards, 1837.

Peneus indicus JEANNEL et RACOVITZA, 1914, p. 383.

Penaeus indicus WOLF, 1934, p. 101.

Subterranean occurrence. Mangapwani Cave, 25 km N. of Zanzibar, E. Africa (JEANNEL et RACOVITZA, 1914). In a clear subterranean lake, the water of which has a temperature of 25.75° C; in total darkness.

Distribution. A widely distributed marine prawn known from throughout the Indo-West Pacific region (the Red Sea and S. Africa to the Malay Archipelago and Australia).

FAMILY ATYIDAE

CARIDINA H. Milne Edwards, 1837.

Caridina nilotica (P. ROUX, 1833).

Subterranean occurrence. In material from Madagascar recently received through the kindness of Dr R. PAULIAN, directeur-adjoint of the Institut Scientifique de Madagascar, a specimen of this species was present from the Ambovonomby Cave near Namoroka, Majunga Province, N.-W. Madagascar.

Distribution. A widely distributed freshwater species, which has been reported from eastern Africa (Egypt to Natal) to the Malay Archipelago and Fiji.

Caridina ? gladiifera J. ROUX, 1929.

Subterranean occurrence. Found together with the above mentioned specimen of *Caridina nilotica* in the Ambovonomby Cave near Namoroka, Majunga Province, N.-W. Madagascar.

A comparison with ROUX's types is needed to definitely ascertain the specific identity of the present material.

Distribution. Caridina gladiifera is a fresh water species and has been reported from several localities in Madagascar.

FAMILY PALAEMONIDAE

PALAEMONETES Heller, 1869.

Palaemonetes antennarius (H. Milne Adwards, 1837).

Palaemonetes varians SPANDL, 1926, p. 90.

Subterranean occurrence. Subterranean water in the region of the lower Narenta River near Bilivir, Dalmatia, Yugoslavia (SPANDL, 1926).

Distribution. A fresh water species known from Italy, the Balkans and Crete.

PALAEMON Weber, 1795.

Palaemon squilla (Linnaeus, 1758).

Palaemon rectirostris VAN GAVER et TIMON-DAVID, 1934, p. 7; VAN GAVER et TIMON-DAVID, 1937, p. 11; WOLF, 1937, p. 770.

Subterranean occurrence. Canal Souterrain du Rove, an underground part of the canal connecting Marseilles with the Rhône River, S. France (VAN GAVER et TIMON-DAVID, 1934, 1937).

Distribution. A marine species, which is also known from brackish waters. It has been reported from the European coasts from the Baltic near Finland to the Mediterranean, the Black and the Caspian Seas.

Palaemon concinnus Dana, 1852.

Subterranean occurrence. Some specimens were found in a freshwater pool in the entrance of a cave named « Blauwe Grot » (Blue Cave) near Mokmer, Biak Island, northern Netherlands New Guinea (January 31, 1952, leg. L.-D. BRONGERSMA; November 19, 1953, leg.

L. VAN DER HAMMEN). The part of the pool from which the present material was obtained, received rather much sunlight and hardly can be classed as a subterranean habitat; the more interior parts could not be explored.

Distribution. Palaemon concinnus is widely distributed in the Indo-West Pacific area (from the Red Sea and E. Africa to the Malay Archipelago and Polynesia), where it occurs in fresh, brackish and salt waters.

MACROBRACHIUM Bate, 1868.

Macrobrachium lamarrei (H. Milne Edwards, 1837).

Palaemon lamarrei MC CAY et WHITE, 1941, p. 38.

Subterranean occurrence. Saltore colliery, a coal mine near the junction of Damodar and Burrakur Rivers, about 130 miles from Calcutta, N.-W. Bengal, India. In small shallow pools in coal mine galleries about 1000 feet underground. Temperature 32° C (MC CAY et WHITE, 1941).

Distribution. M. lamarrei is confined to India, where it lives in fresh or brackish waters.

Macrobrachium australe (Guérin 1838).

Subterranean occurrence. The present species has been found in a pool at the entrance of the « Blauwe Grot » (Blue Cave) near Mokmer, Biak Island, northern Netherlands New Guinea (November 19, 1953, leg. L. VAN DER HAMMEN), a locality already discussed under *Palaemon concinnus*.

Distribution. A freshwater prawn inhabiting the larger part of the Indo-West Pacific region from the Seychelles and Madagascar to the Malay Archipelago and Polynesia.

Macrobrachium lar (Fabricius, 1798).

Macrobrachium lar HOLTHUIS, 1950, p. 176, fig. 37.

Subterranean occurrence. Freshwater rivulet in Guwa Ninggrong Cave, Gunung Sewu, Mula subdistrict, near Jogjakarta, S. Java (HOLTHUIS, 1950), freshwater pool at the entrance of the « Blauwe Grot » (Blue Cave) near Mokmer, Biak Island, northern Netherlands New Guinea (January 31, 1952, leg. L.-D. BRONGERSMA; November 19, 1953, leg. L. VAN DER HAMMEN). For a discussion of the latter locality see under *Palaemon concinnus*.

Distribution. A fresh water species with a wide distribution throughout the Indo-West Pacific region from E. Africa to the Riukiu Islands, the Malay Archipelago and Polynesia.

Macrobrachium hendersoni (De Man, 1906).

Palaemon hendersoni KEMP et CHOPRA, 1924, p. 12, 19; KEMP, 1924, p. 41, pl 3, fig. 5; SPANDL, 1926, p. 89, 140, fig. 105; WOLF, 1934, p. 102.

Palaemon Hendersoni CHAPPUIS, 1927, p. 88, 118, fig. 65.

Subterranean occurrence. Siju Cave, Garo Hills, Assam, India (KEMP et CHOPRA, 1924; KEMP, 1924). An abundant species in the outer parts of the cave, found in fresh water pools and streams up to 1 km from the entrance.

Distribution. Northern India to Yunnan and N. Birma, in fresh water.

Macrobrachium pilimanus (De Man, 1879).

Macrobrachium pilimanus Holthuis, 1950, p. 214.

Subterranean occurrence. Tepid fresh water in Bua Cave near Sidjungdjung, W. Sumatra (HOLTHUIS, 1950), in stalactitic caves, Panumbangan, W. Java (HOLTHUIS, 1950), rivulet in Guwa Gremeng Cave, Gunung Sewu, Mula subdistrict near Jogjakarta, S. Java (HOLTHUIS, 1950).

Distribution. A fresh water species inhabiting Malaya and the Greater Sunda Islands (Sumatra, Java, Borneo).

Macrobrachium faustinum (De Saussure, 1857).

Macrobrachium faustinum CHACE et HOLTHUIS, 1948, p. 23.

Subterranean occurrence. In well, Pos Caranja, W. Lima, Bonaire, Netherlands West Indies (CHACE et HOLTHUIS, 1948).

Distribution. The species inhabits fresh water of the West Indian Islands.

Macrobachium aff. faustinum (De Saussure, 1857).

Macrobrachium olfersii SCHMITT, 1936, p. 372.

Macrobrachium sp. (near *M. faustinum*) CHACE et HOLTHUIS, 1948, p. 23.

Macrobrachium aff. *faustinum* HOLTHUIS, 1952, p. 95.

Subterranean occurrence. In well, Pos Caranja, W. Lima, Bonaire, Netherlands West Indies (SCHMITT, 1936; CHACE et HOLTHUIS, 1948; HOLTHUIS, 1952), in well, Pos di Booi, W. Lima, Bonaire (SCHMITT, 1936), in well, Pos Calbas, W. Lima, Bonaire (CHACE et HOLTHUIS, 1948; HOLTHUIS, 1952).

Distribution. The species has been found in mesohaline waters of the island of Bonaire, Netherlands West Indies, and even has been reported there from the sea.

EURYRHYNCHUS Miers, 1877.

Euryrhynchus wrzesniowskii Miers, 1877.

Euryrhynchus wrzesniowskii MIERS, 1877, p. 662, pl. 67, fig. 2; CHACE, 1943, p. 31, 35; CHACE, 1954, p. 324.

Euryrhynchus wresniowskii SPANDL, 1926, p. 90.

Euryrhynchus Wrzesniowskii CALMAN, 1907, p. 297, fig. 1; CHAPPUIS, 1927, p. 88.

Subterranean occurrence. In a well, Cayenne, French Guyana (MIERS, 1877; CALMAN, 1907).

Distribution. A fresh water species known from British, Dutch and French Guyana.

Euryrhynchus burchelli Calman, 1907.

Euryrhynchus Burchelli CALMAN, 1907, p. 297, fig. 2-8; CHAPPUIS, 1927, p. 88.

Euryrhynchus burchelli SPANDL, 1926, p. 90; CHACE, 1943, p. 31, 35; CHACE, 1954, p. 324.

Subterranean occurrence. The species is only known from the type specimen, which was collected in a well at Pará, Brazil. In view of the fact that the closely related *Euryrhynchus wrzesniowskii* also originally was described from a well and later proved to be widely distributed in surface waters, and as neither species seems to be specially adapted for subterranean life, both are ranged here under the incidental visitors of subterranean waters.

III. ORIGIN OF THE TROGLOBIC SHRIMPS

Much has been written about the origin of the cave fauna, but still little positive information can be given as far as the Natantia are concerned. The fact that of the 27 species of troglobic shrimps known at present not less than 23 belong to genera or subgenera that consist only of troglobic forms, points to a long isolation of these forms; this is also confirmed by the fact that most of the troglobic shrimps have

a small range of distribution. We fully can support therefore SPANDL's (1926, p. 204) opinion that the « Alter der subterranen Wasserfauna ist sicherlich ausserordentlich hoch ».

Many aquatic troglobic species are peculiar in having their closest relatives living in the sea, but there is no positive indication that this situation also exists in the Natantia. The family Atyidae, which contains 15 troglobic and numerous surface species, is essentially a fresh water group and, apart from a very few forms (like the troglobic *Antecaridina lauensis*) which are found in brackish waters, all the species belonging to it are typical fresh water animals. The Palaemonidae contain a large number of fresh water species, but also those living in salt and brackish water are well represented in it. Actually, apart from a very few exceptions, all the freshwater Natantia belong either to the Atyidae or the Palaemonidae. The troglobic species of Palaemonidae (and Atyidae) which form part of a genus that also contains surface forms, are always most closely related to those of the surface species that live in fresh water. The relation of the troglobic Palaemonid genera is rather hard to deal with. *Creaseria* is probably most closely related to *Palaemon* and *Leander*, the latter being exclusively marine, *Palaemon* containing, besides a large number of marine species, a few that live in brackish or fresh waters. *Troglocubanus* is rather closely related to *Palaemonetes*, a genus containing species from brackish, fresh and salt water. *Typhlocaris*, a genus living in brackish water, differs so much from the other Palaemonidae that a special subfamily had to be erected for it; its relation to the other Palaemonid genera is very obscure.

The only troglobic Hippolytid genus lives in brackish or salt water, but all of the species of Hippolytidae are marine forms. The genus *Barbouria* is closest related to the genus *Ligur* Sarato, which contains two species, one of which occurs in rather deep water (360-860 m) in the Mediterranean, the other is known from the Indo-West Pacific region, where it has been found in salt water pools which are shut off from the sea by coral rocks, but still have sufficient communication with the sea to have their waterlevel influenced by the tides. The latter locality shows a peculiar resemblance to that of *Barbouria*.

Summarizing we may conclude that apart from the fact that the taxonomic status of most of the troglobic Natantia points to a very long isolation, very little positive information as to the actual origin of these forms can be given.

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(The papers marked with an asterisk (*) have not been seen by me).