

## Record of the White-clawed Crayfish *Austropotamobius pallipes* (LEREBOULLET 1858) from Plansee (Tyrol, Austria).

by

Leopold FÜREDER & Yoichi MACHINO \*)

**Synopsis:** White-clawed crayfish, *Austropotamobius pallipes*, was found in Plansee, a Tyrolian lake in Austria. The huge population is isolated, unusually distant from its normal distribution in Europe. There is evidence that the crayfish were introduced to Plansee at the beginning of the 20th century, possibly, as morphological comparisons indicate, from northern Italy. In order to protect this valuable population all new crayfish introduction, native or foreign species, must be banned. Also pesticide uses around the areas should be avoided or reduced. Further studies are needed in order to learn more about crayfish biology, physiology and ecology in lentic environments and about their exploitation and protection.

### 1. Introduction:

The European populations of freshwater crayfish have been diminished by several causes, mainly by the crayfish pest between 1880 and 1900. Later river regulations and pollution reduced the formerly rich abundances. The introduction of several exotic species which are successful competitors and vectors of parasites led to an additional reduction of our native species. Therefore, the history of their natural distribution and occurrence within our watersheds is very difficult to explain.

In Austria six species of freshwater crayfish occur, three of them are exotic. *Pacifastacus leniusculus* (DANA 1852) and *Orconectes limosus* (RAFINESQUE 1817) are of Nearctic origin, *Astacus leptodactylus* ESCHSCHOLZ 1823 was introduced from Asia and Eastern Europe. Besides the noble crayfish *Astacus astacus* LINNAEUS 1758 two species of the small crayfish (genus *Austropotamobius*) are known from Austria (WINTERSTEIGER 1985, LAURENT 1988): the stone crayfish *A. torrentium* (SCHRANK 1803) and the white-clawed crayfish *A. pallipes* LEREBOULLET 1858. In our country, the latter is known only from the Gitschtal, a valley in the Carinthian Gail Basin (ALBRECHT 1981). Until now, this was also the only known locality for *A. pallipes* in the whole Danube watershed.

Records regarding the occurrence and distribution of crayfish in Tyrolean freshwaters are scarce, to our knowledge only WINTERSTEIGER (1985) visited a few sites in Tyrol and found three species: *Astacus astacus*, *Austropotamobius torrentium* and *Pacifastacus leniusculus*.

In this publication we report the occurrence of a most probably introduced population of *A. pallipes* in a Tyrolean lake which lies within the Danube watershed. This species reached high densities and showed signs of over-population (parasites).

\*) Authors' address: L. Füreder, Institute of Zoology and Limnology, University of Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria and Y. Machino, Fédération départementale de pêche, Rue du Palais, F-38000 Grenoble, France. Mailing address: 13 Rue Montorge, F-38000 Grenoble, France.

Plansee (47°28'10" N, 10°48'00" E) is a natural lake of glacial origin at an altitude of 976 m above sea level (Fig. 1). Situated near Reutte, in northwestern Tyrol, it is part of the Lech valley (Danube River drainage). The lake is oligotrophic and contains several species of fish, e.g. arctic charr (*Salvelinus alpinus*) and whitefish (*Coregonus* sp.). The water level of the lake is regulated for hydroelectric-power use. To the south, another lake, Heiterwanger See, is connected through a channel with Plansee; this lake is smaller but in its characteristics not much different. Two permanent streams are flowing into Heiterwanger See, i.e. Grundbach and an unnamed stream. Besides the connection with Heiterwanger See, the only permanent inflow into the Plansee is the Torsäulenbach. In summer this stream flows underground for a very short distance before it discharges into the lake. Towards its outflow Plansee gets narrower; a smaller part of the lake continues, which is called Kleiner Plansee. After a dam the Archbach forms the outflow of Plansee.

### 3. Methods:

During a fishing trip in Tyrol in 1993, one of the authors (Machino) obtained two specimens of *Austropotamobius* from a professional fisherman who indicated that the crayfish were caught in Plansee. The specimens were conserved in alcohol for further study. Surprisingly, close examination showed that the samples were not stone crayfish but white-clawed crayfish, *A. pallipes*, a species previously unknown from Tyrol (MACHINO 1994). Therefore, additional field observations were planned for 1994. On a sampling trip in August 1994 we visited several sites in Tyrol, among them were Plansee and Heiterwanger See with all their inflowing and outflowing streams and rivers. From places where we found crayfish, we took samples for the evaluation of their morphological characteristics. Described lakes were visited during the night. All specimens were caught by hand in shallow water, preserved in 70 % alcohol, measured and identified back in the lab. Deeper areas could be observed by snorkeling. Most specimens are stored at the University of Innsbruck, Institute of Zoology and Limnology, some in Grenoble, and a few at the Zoologische Staatssammlung in Munich.

### 4. Results and Discussion:

During the nights of 3 and 4 August 1994, 32 specimens of crayfish were caught by hand (Fig. 1, Table 1). All of them showed characteristics of white-clawed crayfish, i.e. the presence of a "talon" on the second pleopod (= gonopod 2) in males and the absence of a denticulate ridge on the ventral side of the antennal exopod (BOTT 1972, LAURENT 1988, PÖCKL 1992). Most of the specimens caught in Plansee, were taken at the eastern end of the lake, near its outlet in the smaller western bay of the lake (Kleiner Plansee), and some in the outlet (the Archbach) at Frauenbrünnele Bridge (Fig. 1). Since *A. pallipes* like all freshwater crayfish is nocturnal, the animals could not be detected during the day, at night, however, along the whole northern and eastern shore. At one site, Fürchterlichhütte, on the east side of Plansee, no specimen was found at all except for one empty exuvia. Perhaps the sampling time (21:00) was too early for the crayfish to appear at the southern shore. On the opposite shore hundreds of specimens could be observed between 22:00 and midnight; only some of them were collected. The observed individuals were grazing in a depth of less than 60 cm.

Several years ago H. PEHOFER (pers. comm.) from the University of Innsbruck recorded during a SCUBA-diving trip to Plansee freshwater crayfish in a depth of about 3 to 5 m. Also W. ERNST from the fishery's authority recorded this species being frequently found in fish traps. These and our observations indicate that *A. pallipes* has reached very high abundances. This freshwater crayfish is not suffering from interspecific competition, since it reached these for an

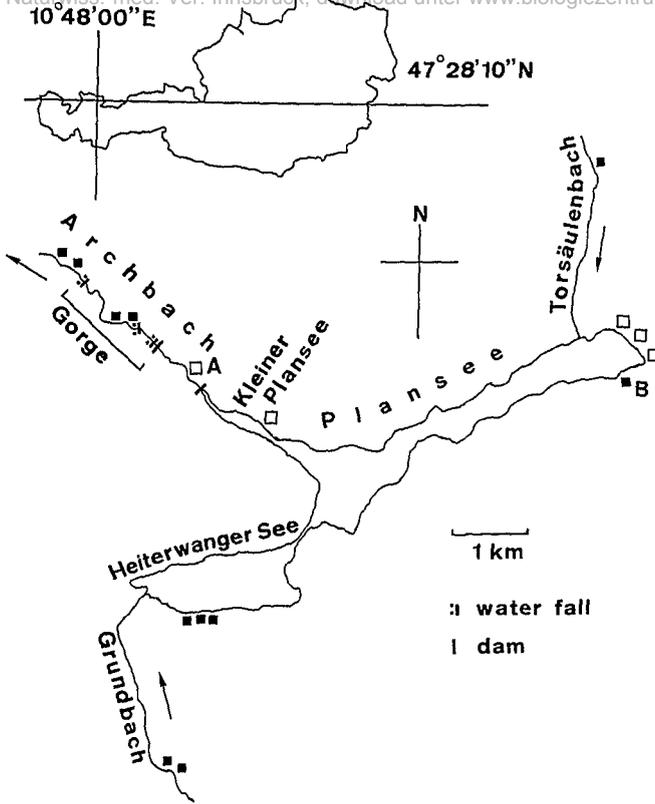


Fig. 1: Map of Plansee and its surrounding waters in Tyrol, Austria. A: Frauenbrünnele bridge; B: Fürchterlichhütte. White squares indicate sites where white-clawed crayfish (*Austrobotanobius pallipes*) was sampled, black squares, sites where no crayfish were observed (see text for detail).

oligotrophic lake unusual high densities. The distribution within the lake and the watershed probably covers Plansee and Heiterwanger See, the lake connected to Plansee through a small channel (Fig. 1). Although we could not find any during our trip in Heiterwanger See, fishermen catch them in their traps in lower frequencies than in Plansee (ERNST, pers. comm.). We also looked very carefully at the inflowing streams (Grundbach and Torsäulenbach) and also the single outlet (Archbach). Both inflowing streams and their tributaries (not shown in Fig. 1) did not have any crayfish. The substrate of Torsäulenbach appeared to be too unstable and its nutrient load to low, Grundbach however, seemed to have suitable habitats for crayfish. Only the uppermost region of the river Archbach right after the outflow between the two dams (one after Kleiner Plansee and the other just before the Gorge) seemed to offer the right conditions for crayfish to survive.

The lower limit of the apparent distribution is at a dam just above the Archbach gorge (Fig. 1). In the gorge, discharge is reduced because water is diverted for electric power at the two dams upstream. The gorge is about 2 km long and consists of three high waterfalls (Stuibenfälle). Below, discharge increases again by water release of the power station. In the gorge we found bullhead (*Cottus gobio*) and brown trout (*Salmo trutta*), but no crayfish. The area appeared to be too rocky (solid rocks) without hiding areas, so that the crayfish could easily be preyed upon brown trout and bullhead. Wintering is not easy for the same reason, and the river occasionally can dry

Table 1: Number of sampled white-clawed crayfish, *Austropotamobius pallipes* (numbers in parenthesis are total lengths, i.e. sizes from rostrum to telson in cm).

Site	Male	Female	Total
Plansee	14 (4.8 - 8.2)	12 (4.8 - 6.2)	26
Kleiner Plansee	2 (8.0 - 8.7)	1 (6.8)	3
Archbach (Frauenbrünnele Bridge)	3 (6.2 - 8.1)	—	3
Total	19	13	32

up when the dams close. Below the gorge, the river flows very fast, with very high daily or weekly water-level fluctuations (we observed 1 to 1.5 m). The colonization of the Archbach below the gorge by white-clawed crayfish from Plansee also appears to be a difficult strategy. They would have to migrate or drift down from Plansee either through the gorge, with three big water-falls, or through the underground pipes through the hydropower turbines. In addition, water-level fluctuations of the Archbach below the gorge do not provide a stable habitat for white-clawed crayfish. The presence of stone crayfish below the gorge (MACHINO & FÜREDER in prep.) may also contribute to the absence of white-clawed crayfish. According to LAURENT (1988) there is only one single example of the coexistence of the two species in a river on the Dalmatian coast, but usually they do not coexist. At the moment we can not evaluate what interaction between these species may occur if any.

A similar example of crayfish introduction is reported from a French lake, Lac Pavin (LECOQ 1860, RICO 1876). Lac Pavin (1197 m a.s.l.) in Puy-de-Dôme had no crayfish prior to their introduction in 1859 or 1860. They became so abundant that bait-fishing for trout and other fishes became difficult because crayfish attacked baits and hooked fishes (BERTHOULE 1890, BRUYANT & EUSÉBIO 1903). It is interesting that the outlet of the lake, Couze de Pavin (= Couze de Besse), remained devoid of crayfish (BERTHOULE 1890, EUSÉBIO & REYNOUARD 1926, OMALY 1968). OLIVIER (1945) identified the crayfish species as *A. pallipes*. In 1968 they were still present in the lake (OMALY 1968), but their present occurrence is unknown.

Habitat requirements of white-clawed crayfish in lentic environments at high altitudes are not clearly understood. BOTT (1972) characterizes the species of *Austropotamobius* as occurring mostly in streams and rivers. LAURENT (1988) states that they are also abundant in lakes but that they rarely occur in lakes larger than 1000 hectares. Also BOTT (1972) explains the findings in bigger lakes, like L. Geneva and L. Constance, as being imported from nearby river mouths. Most occurrences in lakes are reported from the littoral zone, e.g. white-clawed crayfish of Lac des Gaillands (1000 m a.s.l.), a small lake near Chamonix (Haute-Savoie, France, LAURENT 1985).

Unregulated lake and river shorelines usually provide hiding places (undercut banks, rocks, tree roots, borrows) which are essential for the survival of the crayfish (CTGREF 1979, LAURENT 1988, HAGER 1994). At the sampling time Plansee and Heiterwanger See were not at their maximum water level, the lake shores were not useful as hiding places. Along the northern shore of Plansee the bank is artificial, built of stones and rocks for road construction and stabilization. Crayfish were observed feeding along the shore at night (22:00 - 00:00). Because of the lack of hiding places they have to migrate to deeper areas during the day. Our and PEHOFER's observations suggest a diurnal migration, during the day they hide from predators and go deeper where they find shelter areas, at night they migrate to the shore to feed.

Prior to our findings the Gitschtal area in Carinthia was the only known area in the Danube watershed where the white-clawed crayfish was recorded (ALBRECHT 1981). The occurrence

of this species in Plansee and the upper Archbach cannot be explained as an extension of its natural distribution (for a discussion in detail see BOTT 1972, LAURENT 1988). People near the Plansee report from a traditional story, that "about 70 years ago (i.e. 1920 to 1925) a Mr. Singer brought crayfish from the Reutte train station in a basket covered with moss to keep them wet". Accordingly, the Plansee population of *A. pallipes* was most probably introduced by man. Perhaps even earlier than this story tells.

The origin of the white-clawed crayfish in Plansee seems to be difficult to be explained so far, since the story does not tell which species nor from where it came from. Although SPITZY (1973) speculates the two species *A. pallipes* and *A. torrentium* as being economically unimportant and ALBRECHT (1983) believes that *A. torrentium* was not transplanted by man because of its small size and low reproduction rate, the latter author (ALBRECHT 1983) reports for *A. pallipes* several historical examples of human introductions throughout Europe. If the species was introduced it is most probably of Italian origin. Because of morphological differences (chela shape, rostrum form and number of spines behind the cervical groove) we believe that their ancestors were not French. They also differ morphologically from those of the Gitschtal in Carinthia. Although we are unable to present a statistical comparison of morphological characteristics, due to an insufficient number of large specimens from Plansee, these crayfish may have come from the Italian regions of Trento or Bolzano. Morphological characteristics of *A. pallipes* var. *trentinicus* described by ALBRECHT (1982) resemble our specimens from Plansee. The present Italian provinces Trentino and Alto Adige were Austrian territory prior the First World War. Since a rich trade and translocation of crayfish is reported for the Habsburgian Empire our explanation appears to be possible. Now *A. pallipes* in Plansee seems to be over-populated, as evidenced by the high number of individuals and by the infection of all specimens with parasites. They belong to the group of parasitic oligochaetes of the family Branchyobdellidae. According to SCHÄPERCLAUS et al. (1979) the leech-like parasitic worms keyed out to *Branchyobdella pentodonta* WHITMAN. They live attached to the ventral skin of the abdomen and the soft skin at the joints and gills, to feed on mucus and haemolymph from their hosts. A few parasites would not harm their hosts, however mass occurrence are reported to cause problems. According to SCHÄPERCLAUS et al. (1979), *Branchyobdella*-species can play a specific role as a vector of *Aphanomyces astaci* (SCHIKORA 1903), the fungus that causes the crayfish plague.

White-clawed crayfish are mainly regarded as animals of rivers and creeks. This example (among others) indicates that this animal can also live in lakes. The Plansee crayfish offer an excellent opportunity to study the biology, physiology and ecology of white-clawed crayfish in a lentic environment. Further studies can tell how we better protect their habitats and perhaps how we wisely exploit them.

The crayfish in Plansee are not yet in danger, however the introduction of alien species, like *Orconectes limosus* or *Pacifastacus leniusculus*, could wipe out their population. The crayfish plague invasion in England (and even in our country) gives us a painful example of the consequences of unwise introductions (SPITZY 1973, ALDERMAN et al. 1990, HOLDICH 1991). Many human activities and their effects such as pollution, river regulation and introduction of foreign species have altered the natural situation in our watersheds. Crayfish are regarded as indicators of a clean and healthy environment. There is a need for protection treatments in Plansee, the growing tourism should be kept off in some areas of the shore. The water should be kept devoid of pesticides and fertilizers; here this means all portions of the Rotlech (tributary of the Lech), Heiterwanger See, Plansee and the Archbach because of the underground pipe-line network connecting them for hydropower generation.

Acknowledgments: We thank A. Long and P.J. Laurent for the identification of the 1993's crayfish samples, and R. Pechlaner who provided the opportunity for one of the authors (Machino) to see these crayfish

unusual for Tyrol in 1993. We are also grateful to W. Ernst for his help and useful advice during our sampling trip.

#### 4. References:

- ALBRECHT, H. (1981): Die Flußkrebse des westlichen Kärnten. — *Carinthia* II, **91**: 267 - 274.
- (1982): Das System der europäischen Flußkrebse (Decapoda, Astacidae): Vorschlag und Begründung. — *Mitt. Hamb. Zool. Mus. Inst.* **79**: 187 - 210.
- (1983): Besiedlungsgeschichte und ursprüngliche holozäne Verbreitung der europäischen Flußkrebse (Decapoda: Astacidae). — *Spixiana* **6**: 61 - 77.
- ALDERMAN, D.J., D. HOLDICH & I. REEVE (1990): Signal crayfish as vectors in crayfish plague in Britain. — *Aquaculture* **86**: 3 - 6.
- BERTHOULE, A. (1890): Les lacs d'Auvergne (orographie, faune naturelle — faune introduite). — Société Nationale d'Acclimatation, Paris, 136 pp.
- BOTT, R. (1972): Besiedlungsgeschichte und Systematik der Astaciden West-Europas unter besonderer Berücksichtigung der Schweiz. — *Rev. Suisse Zool.* **79**: 387 - 408.
- BRUYANT, C. & J.-B.-A. EUSÉBIO (1903): Matériaux pour l'étude des rivières et lacs d'Auvergne: introduction à l'aquiculture générale. — *Bull. Hist. Sci. Auvergne* **23**: 271 - 303, 331 - 372, 393 - 432, 467 - 500, iv.
- CTGREF (1979): Premières observations sur une population naturelle d'écrevisses indigènes *Austropotamobius pallipes* Ler. à Puydesseaux dans les Landes. — Section QE, CTGREF de Bordeaux, Cestas, 52 pp.
- EUSÉBIO, A. & J. REYNOUARD (1926): Le lac Pavin — le Creux de Soucy: guide du touriste et du naturalist. — Bibliothèque Municipale et Universitaire de Clermont-Ferrand, 55 pp.
- HAGER, J. (1994): Anatomie und Biologie der heimischen Krebse. — *Österreichs Fischerei* **5/6**: 136 - 140.
- HOLDICH, D. (1991): The native crayfish and threats to its existence. — *British Wildlife* **2**: 141 - 151.
- LAURENT, P.J. (1985): Une station d'écrevisse à pieds blancs: *Austropotamobius pallipes* Lere. (Decapoda — Astacidae) en zone périurbaine. — *Bull. mensuel Soc. Linn. Lyon* **54**: 77 - 88.
- (1988): *Austropotamobius pallipes* and *A. torrentium* with observations on their interactions with other species in Europe. — In: HOLDICH, D.M. & R.S. LOWERY (Hrsg.): *Freshwater crayfish: biology, management and exploitation*. Croom Helm, London, p. 341 - 364.
- LECOQ, H. (1860): De la pisciculture dans le département du Puy-de-Dôme. — *Bull. Soc. Impér. Zool. Acclimatation* **7**: 578 - 589.
- MACHINO, Y. (1994): L'écrevisse à pieds blancs en Autriche occidentale? — *L'Astaciculteur de France* **39**: 2.
- MACHINO, Y. & L. FÜREDER (in prep.): Stone crayfish, *Austropotamobius torrentium* (SCHRANK 1803), in Archbach, Tyrol (Austria).
- PÖCKL, M. (1992): Bestimmungsschlüssel für österreichische Flußkrebse (Kl. Crustacea, U.kl. Malacostraca, O. Decapoda, Abt. Astacura). — *Lauterbornia* **10**: 1 - 8.
- OLIVIER, L. (1945): Quelques éléments de la faune littorale des lacs Bourdouze, de Chambédaze, Chambon, de Moncineyre et Pavin. — *Bull. Historique et Scientifique Auvergne* **65**: 231 - 234.
- OMALY, N. (1968): Le lac Pavin: historique et hydrobiologie. — *Rev. Sci. Nat. Auvergne* **34**: 7 - 31.
- RICO, B. (1876): L'aquiculture en Auvergne. — *Bull. Soc. Acclimatation* **3**: 165 - 191.
- SCHÄPERCLAUS, W., H. KULOW & K. SCHRECKENBACH (1979): *Fischkrankheiten*. — Akademie-Verlag, Berlin, 1089 pp.
- SPITZY, R. (1973): Crayfish in Austria, history and actual situation. — In: S. ABRAHAMSSON (Hrsg.): *Freshwater Crayfish*, Lund: 9 - 14.
- WINTERSTEIGER, M.R. (1985): Flußkrebse in Österreich: Studie zur gegenwärtigen Verbreitung der Flußkrebse in Österreich und zu den Veränderungen ihrer Verbreitung seit dem Ende des 19. Jahrhunderts — Ergebnisse limnologischer und astacologischer Untersuchungen an Krebsgewässern und Krebsbeständen. — *Diss. Naturwissenschaftl. Fak., Univ. Salzburg*, 181 pp.