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AN UNUSUAL LOCATION FOR *ERGASILUS SIEBOLDI* NORDMANN (COPEPODA, ERGASILIDAE) ON THE OPERCULUM AND BASE OF PECTORAL FINS OF THE PIKEPERCH (*STIZOSTEDION LUCIOPERCA* L.)

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Ergasilus sieboldi infestation of the pikeperch (*Stizostedion lucioperca*) is extremely common in Lake Balaton. In the summer and autumn, these parasitic copepods have high prevalence and intensity on pikeperch of more than 20 cm body length. Typically, *Ergasilus* establish themselves in the folds on the external surface of the operculum and on the base of the pectoral fins, and only a small proportion cling to the gill filaments. Infestation is rare and of low intensity in pikeperch of less than 20 cm body length. The Volga pikeperch (*Stizostedion volgense*) has low-intensity infestation irrespective of age. The lesions caused by copepods present on the operculum are restricted to the epithelium even if infestation is intensive.

Key words: Ergasilosis of the operculum, pikeperch, Volga pikeperch, Lake Balaton, seasonal occurrence, epithelial damage

Ergasilus sieboldi is a common parasite with a broad host range of freshwater and brackish water fishes. Numerous reports are available on its development and occurrence (Gnadeberg, 1949; Lahav and Sarig, 1967; Zmerzlaya, 1972; Pojmanska, 1984; Abdelhalim et al., 1991; Tuuha et al., 1992) and its pathogenic effect on the fish (Dogiel et al., 1961; Einszporn, 1965*a*, *b*; Einszporn-Orecka, 1973; Czeczuga, 1980; Bauer et al., 1981; Pojmanska, 1984). Lester and Roubal (1995) published a review of the development, ecology and pathology of fish-parasitic arthropods including *Ergasilus*. From Lake Balaton, *E. sieboldi* was first recorded by Daday (1986), who detected free-living males in the lake. Its occurrence on Lake Balaton fishes was thoroughly studied by Geyer (1939), who mentioned that *E. sieboldi*, when it caused intensive infestation in Balaton pikeperch, was present on the external surface of the operculum in addition to the gill itself. The possibility of such unusual location was suggested also by Bauer et al. (1981). The parasitic copepods of Lake Balaton fishes were surveyed by Ponyi and Molnár (1969).

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This paper reports the results obtained on the seasonal incidence and site selection characteristics of *E. sieboldi* during a survey of the parasite fauna of Lake Balaton pikeperch.

Materials and methods

The investigations were carried out in the fishing period (between March and November) of the years 1994 through 1996. Fish subjected to full parasitological dissection included 55 pikeperch (*Stizostedion lucioperca*) and 30 Volga pikeperch (*Stizostedion volgense*) specimens in 1994, 53 pikeperch and 4 Volga pikeperch specimens in 1995, and 48 pikeperch and 4 Volga pikeperch specimens in 1996. The body length of the dissected pikeperches varied between 21 and 52 cm, with a total of 16 pikeperches measuring less than 21 cm. The intensity of *E. sieboldi* infestation of the gills was determined by stereomicroscopic recording of copepods adhering to the hemisegments. Copepods adhering to the operculum and the base of fins were scraped off into a Petri dish together with the mucus surrounding them, and were counted under stereomicroscope. Some of the results of the parasitological survey conducted in 1994 have already been published (Molnár and Székely, 1995); thus, data on *Ergasilus* infestation in the year 1994 are identical with the results reported in the above-cited paper, and were summarised on the basis of the dissection reports. In 1995 and 1996, special attention was paid to monitoring the location, seasonal incidence and numbers of the copepod parasites. Data on the histopathological changes caused by the copepods were obtained by histopathological examination of copepod-infected tissues (operculum, gills) processed after fixation in Bouin's solution. After embedding them in paraffin, the fixated organs were cut into 4 μm thick sections which were then stained with haematoxylin and eosin. The microphotographs were taken with a camera mounted on a Jenaval microscope.

Results

Ergasilus copepods were detected on the gill filaments, in the folds on the external surface of the operculum, and on the base of the pectoral fins. Due to the presence of large numbers of *Epistylis* commensalists adhering to the copepods, the parasites located in the folds of the operculum could be seen already by gross inspection as an off-green layer covering the opercular folds.

As shown in Figs 1 and 2, *E. sieboldi* copepods were present both on the external surface of the operculum and on the gill filaments in the majority of pikeperches longer than 20 cm, irrespective of the season. At the same time, *E. sieboldi* infestation restricted to the gill filaments was seen in only one out of the

16 pikeperches measuring less than 20 cm. The prevalence of infestation was especially high (95%) in pikeperches bigger than 40 cm while it was only 31% among the pikeperch specimens smaller than 30 cm. Smaller fish were characterised by infestation of the gill filaments while bigger ones by that of the operculum. A low prevalence of infestation was observed in the Volga pikeperch: only 6 out of the 38 specimens measuring 13–29 cm (average body length: 22 cm) examined during the 3 years were infected by a low number of copepods, and even that infestation was restricted to the gill filaments.

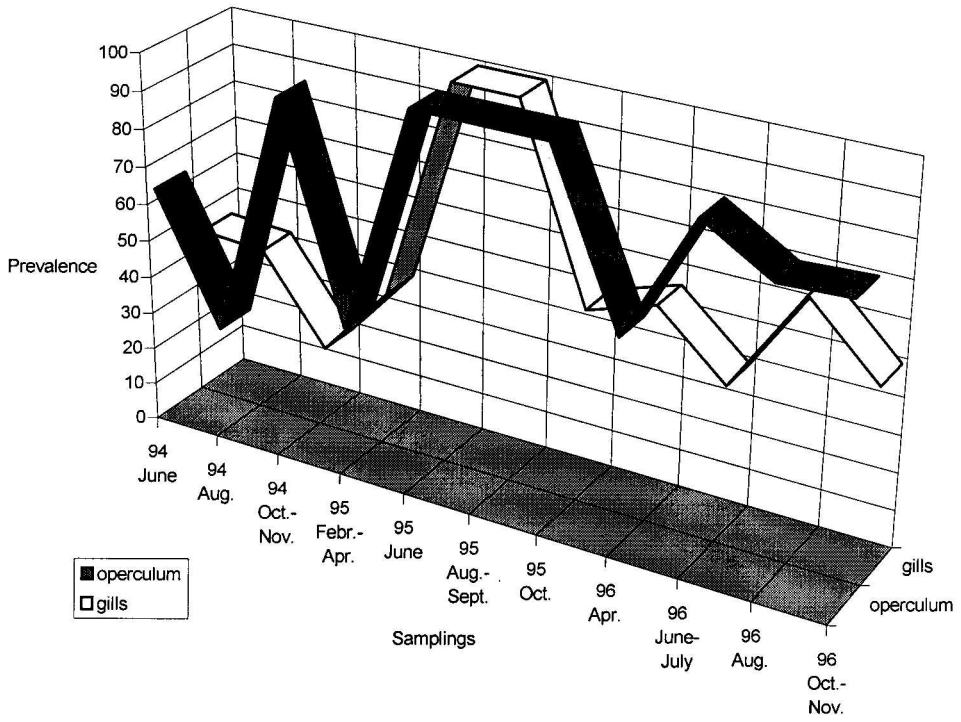

Fig. 1. Prevalence of *Ergasilus sieboldi* infestation of Lake Balaton pikeperch exceeding 20 cm in body length in the period 1994 through 1996

In some cases very intensive infestation was found in pikeperches exceeding 21 cm in body length, and the majority of copepods were located in the folds of the operculum and on the base of the fins (Fig. 3). Infestation was especially severe in the summer months and in the second half of the year: in 1995 its prevalence was 100% and its intensity was also around or above 100 in that period. The number of copepods adhering to the body surface was 4 to 8 times higher than that of parasites clinging to the gill filaments. About 5 times as many copepods were located on the operculum than on the base of the fins.

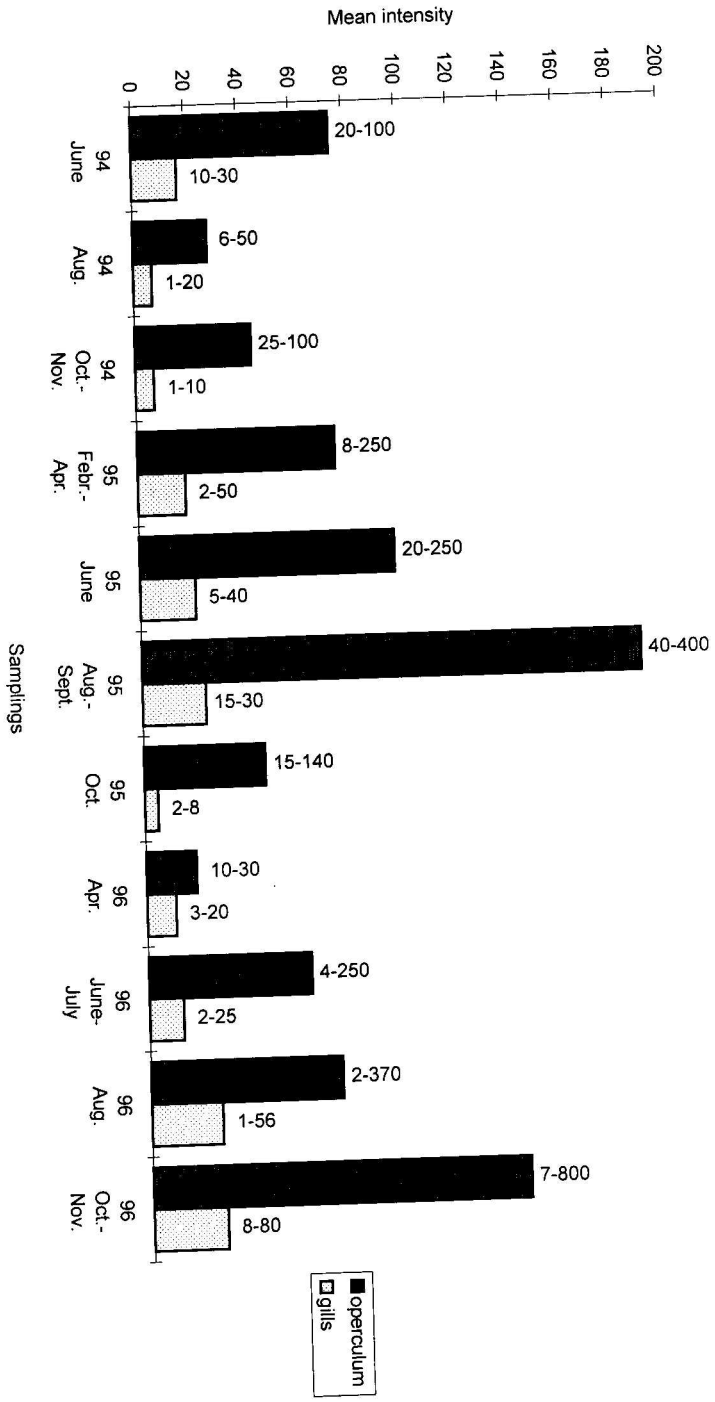

Fig. 2. Intensity of *Ergasilus sieboldi* infestation of Lake Balaton pikeperch exceeding 20 cm in body length in the period 1994 through 1996. Numbers above columns show the range of intensity of infection

Fig. 3. Ergasilus copepods located in the folds of the operculum in pikeperch

Absence of gill filaments as well as whitening and thickening of their tips were seen around *Ergasilus* specimens located on the gill filaments, which enabled an easy diagnosis of infestation even without microscopic examination. Apart from causing a slight reddening of the skin, the copepods did not produce typical signs on the body surface, and attention was called to the infestation by their mere physical presence.

In histological sections of the operculum (Fig. 4), numerous *Ergasilus* copepods bearing an egg sac were seen among the transected folds on the external surface of the operculum. The copepods were attached to the epithelium of the folds with their cephalic end and held themselves in place with their antennae sunken deep into the epithelium. Around the copepods, transected specimens of *Epistylis* commensalists holding on to the copepods' body surface by a thin peduncle were seen in large numbers. The histopathological changes were restricted to the stratified epithelium of the operculum, where impressions and shreds of the surface epithelium were seen around the site of attachment of copepods' cephalic end (Fig. 4) as well as in places where the antennae penetrated the epithelium (Figs 5 and 6). Mechanical injury caused by the antennae was also seen in the deeper layers of the epithelium (Fig. 7), with destruction of epithelial cells, haemorrhages, and appearance of round cells. No cellular elements were seen in the copepods' transected gut, which was filled by structureless, light-staining round formations or amorphous material (Fig. 8).

Fig. 4. Intensive *Ergasilus sieboldi* infestation in the grooves (b) among the folds of the operculum (a). Besides egg sac bearing *Ergasilus* copepods (big arrow) directed towards the epithelium of the folds with their cephalic end, cross sections of *Epistylis* commensalists (open arrow) adhering onto the copepods' body surface can be seen. In the epithelium of the folds, note the signs of degenerative processes and the cross sections of antennae (small arrow) sunken into the epithelium. × 40

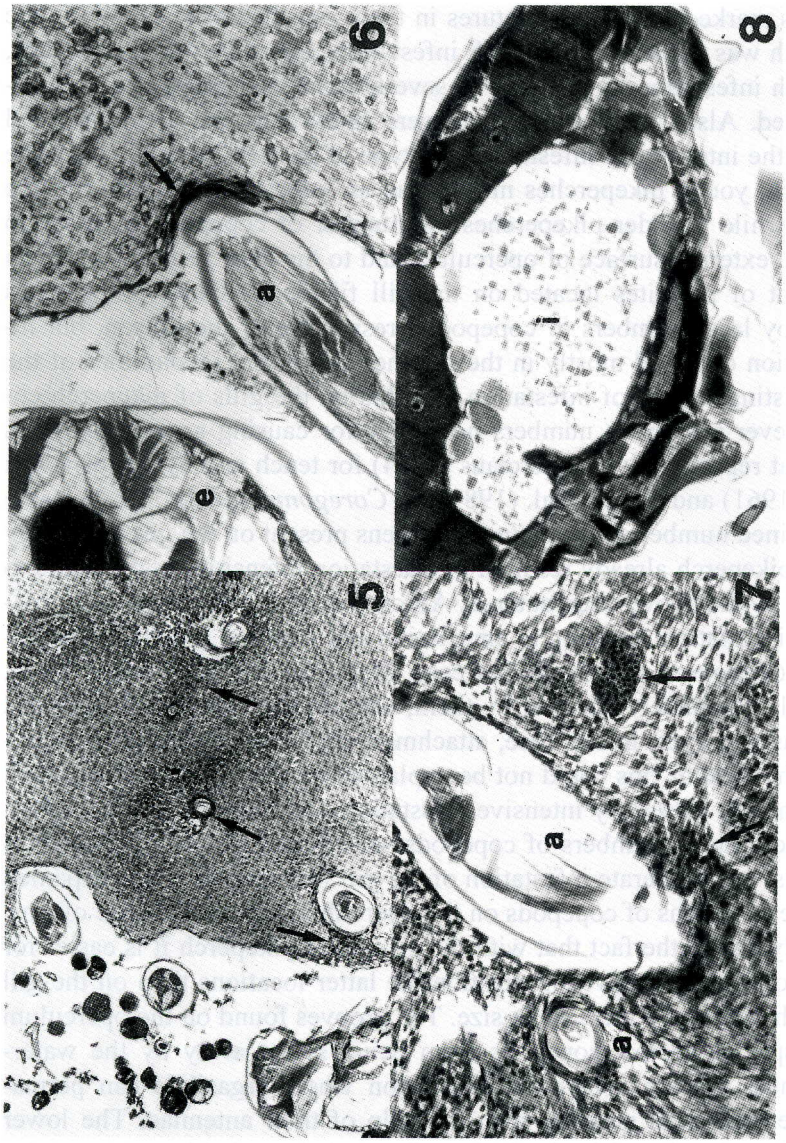

Fig. 5. Tissue injuries caused by the antennae of *Ergasilus sieboldi* (arrow) in the epithelium covering the folds of the operculum. × 80; *Fig. 6.* Disintegration of the surface epithelial cells (arrow) around the site of penetration of the antennae (a) of *Ergasilus sieboldi* (e) into the epithelium of the operculum. × 220; *Fig. 7.* Tissue injury and haemorrhages (arrows) around the antennae (a) of *Ergasilus sieboldi* deep in the epithelium of the operculum. × 220; *Fig. 8.* Cross section of the intestine (i) of *Ergasilus sieboldi*. No cellular elements of host origin can be seen in the intestinal content. × 220

Discussion

The present survey has demonstrated that *E. sieboldi* is a common parasite of the pikeperch and Volga pikeperch of Lake Balaton. However, *Ergasilus* infestation shows markedly different features in these two fish species. While the Volga pikeperch was characterised by gill infestation caused by a few copepods, in the pikeperch infestation by as many as several hundred copepods was occasionally recorded. Also, major differences were found between young and old pikeperches in the intensity of infestation and type of parasite location. Like the Volga pikeperch, young pikeperches mostly had an infestation restricted to the gill filaments, while in older pikeperches the number of copepods adhering to the folds on the external surface of operculum and to the base of fins was much higher than that of parasites located on the gill filaments. Older pikeperches were infected by large numbers of copepods irrespective of the season, but intensive infestation occurred mostly in the summer and in the second half of the year. An interesting feature of infestation was that on the gills of pikeperch copepods were never present in numbers necessary for causing an infestation as intensive as that reported by Schäperclaus (1954) for tench and by Petrushevski and Shulman (1961) and Bauer et al. (1981) for *Coregonus* species. At the same time, the combined number of *Ergasilus* specimens present on the gills and body surface of the pikeperch already resulted in infestation intensities comparable to those observed by the above-cited authors. Abrosov et al. (1963) observed intensive *Ergasilus* infestation resulting in emaciation and retarded growth in the Peled whitefish (*Coregonus peled*). In that case, *Ergasilus* copepods were found, besides the gills completely covered by them, also on the base of the fins and around the anus and eyes. In our case, attachment of the copepods to the operculum and to the base of fins could not be explained by the highly intensive gill infestation, although extremely intensive infestation was found in several cases. Very often much higher numbers of copepods were found on the body surface than on the gills, and moderate infestation of the gill filaments was accompanied by the presence of dozens of copepods on the operculum and on the base of fins. This is probably due to the fact that with the growth of pikeperch it is easier for the copepods to keep themselves in position the latter locations than on the gill filaments which constantly increase in size. The grooves found on the operculum of pikeperch species protect copepods from being swept away by the water-current and, thus, provide a favourable location where ergasilids can permanently hold themselves in position with the help of their antennae. The lower intensity of infestation found in the Volga pikeperch is probably not a species characteristic but due to differences in body size. Namely, older specimens of the Volga pikeperch reach a size equal to that of young pikeperch, and the intensity of infestation found in them also roughly corresponds to that of the latter.

Although intensive infestation is typical of the pikeperch, *Ergasilus* infestation can be considered fairly common in Lake Balaton and has been detected in numerous fish species other than the pikeperch (Ponyi and Molnár, 1969; Molnár and Székely, 1995). This means that the infestation of several fish species may play a role in the maintenance and seasonal variation of the ergasilid population.

Despite the large number of parasites colonising the host, relatively moderate pathological changes can be observed at the attachment site of the parasite. The epithelial erosions seen around the site of attachment of the parasite's mouth organs, as well as the haemorrhages, tissue necrosis and proliferation observed around the site of penetration of the antennae into the corium are undoubtedly indicative of injuries of the common integument; that damage is, however, by far not as significant as the sometimes fatal disease resulting from the damage done by the parasite to the gills (Petrushevski and Shulman, 1961; Bauer et al., 1981). The relatively low pathogenicity of *E. sieboldi* is especially striking in comparison with the extremely high pathogenicity of the only slightly larger *Caligus* and *Lepeophtheirus* species parasitic on the skin of salmonids; namely, according to Kabata (1974), Jones et al. (1990) and Jónsdottir et al. (1992), already a few specimens of these latter parasites can cause ulcerous lesions and mortality in marine cage cultures.

The pathogenic effects of *E. sieboldi* can be attributed to the parasite's attaching mechanism and mode of feeding. While the changes described by Schäperclaus in 1954 (thickening and whitening of the tips of gill filaments, mucus production, desquamation, etc.) were well visible on the gills already in the presence of relatively few copepods, no macroscopic lesions other than a slight reddening of the skin were seen at the sites of parasite infestation on the body surface. Histologically, the haemorrhages occurring around the penetration sites of claws were rather small, and the degenerative and proliferative processes were not commensurate with the number of copepods present. The epithelial injuries seen around the copepods' mouth organs result from the feeding of the parasite. According to Einszporn (1965*b*), the copepods feed on goblet cells and epithelial cells, and their alimentary canal contains large numbers of epithelial and blood cells among the cellular elements of host cell origin. In this study based upon the examination of a relatively low number of sections, we could not detect any cellular elements in the copepods' intestine. Although we do not wish to refute Einszporn's (1965*a, b*) results based upon thorough studies, we cannot rule out the hypothesis of Halisch (1940), according to which the mode of feeding of ergasilids may involve external digestion and the bulk of food reaching the alimentary canal consists of already digested material.

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