Short Paper

Impact of the 1999 earthquake on mountain stream fishes in Taiwan

Lee-Shing FANG,1* I-Shiung CHEN,1 Kwee Siong TEW,2 Chiao-Chuan HAN,1 Tsai-Fu LEE1 AND I-Ming CHEN2

1National Museum of Marine Biology & Aquarium, Checheng, Pingtung 944 and 2Institute of Marine Resources, National Sun Yat-Sen University, Kaohsiung 804, Taiwan 202

KEY WORDS: earthquake, stream fish population and reproduction, Taiwan.

A catastrophic earthquake, rated 7.3 on the Richter scale, hit central Taiwan on 21st September, 1999. As well as thousands of human casualties, a major change in the natural environment had occurred in the mountain regions. Here we report the immediate impact of the earthquake on: (i) the composition of the fish population of varying size classes; and (ii) the reproduction of fish in the mountain stream. The study’s results demonstrate that the most severe catastrophe on these fishes was by the heavy mudslide resulting from precipitation after the event.

The epicenter of the quake was located at 23°85′N and 120°78′E, in Nantou County. The fault ran through several independent rivers. Among them, Ta-Chia River was a place where we had studied freshwater fishes between October 1988 and August 1992.1 After the earthquake, we re-visited the upper stream section of the river monthly between October and December 1999 to investigate its impact on the fishes.

Size composition of the population in 1999 of two dominant endemic species, Zacco pachycephalus and Acrossocheilus paradoxus, was compared with the results of 1988–1993 at two sites (Fig. 1). Each site used to be composed of a 200 m² deep pool with a depth of 2–3 m and a shallow water area of approximately 80 m². A landslide caused by the earthquake had buried almost one-third of the deep pool; however, the shallow water area, which was usually against the mountain side, remained unaffected. Forty-five observations (n=45) had been performed between October 1988 and August 1992, and nine observations (n=9) were done between October and December 1999. A comparison of the results of the fish data (Fig. 2), which were collected by visual census as described in a previous work,1 showed that the number of juveniles (1–3 cm) born after the earthquake had declined dramatically (P<0.05, Mann–Whitney’s rank sum test) compared with previous years’ records of the same months.1 In the case of A. paradoxus at Kukuan, no juveniles were sighted. It was surprising to see that the numbers of adult fish (>7 cm), which were normally few at this time of the year, comprised the highest percentage of the population. From our observations, most of the boulders and crevices between the bedrock, among which large individuals usually hide, had collapsed after the earthquake. Physically, this explained why the large adults were more visible in the pool as they no longer had any shelter in which to hide. Behaviorally, this also suggested that most fishes were able to escape from their shelters where they usually stay at night2 before the earthquake (at 01:47 am), indicating they may have sensed the event in advance.

Regardless of the flat, shallow water area, in which breeding and nesting of these stream fishes normally takes place, was unaffected by the earthquake, and that the juvenile aggregates were less disturbed here, the number of juveniles for 1999 was markedly reduced. As most cyprinid fishes in the mountain streams of central and southern Taiwan start breeding in the beginning of the dry season (October to May),3 the decreased number of their offspring may be a result of the physiological anomaly from the environmental stress that interfered with normal reproduction. The sensitivity of fish to earthquake4 and vibration5 has been documented, but its influence on the behavior, compo-

*Corresponding author: Tel: 886-8-882-4485. Fax: 886-8-882-4488. Email: lsfang@mail.nmmba.gov.tw
Received 11 July 2001. Accepted 17 April 2001.
Earthquake impact on fishes in Taiwan

FISHERIES SCIENCE

Fig. 1 Location of the sites studied (Kukuan and Tungmau) along the central part of Ta-Chia River, Taiwan.

situation and reproduction on a wild population has not yet been reported.

Moreover, the most destructive damage to these mountain stream fishes by the earthquake occurred after the first heavy rainfall in the following February. The quake, which lasted 2 min, had caused a vast landslide along the river, piling up millions of tonnes of soil and rock in the valley. When the monsoon started to bring in precipitation, the loosened soil turned into a thick mudflow that flowed into the river, burying everything in its way. This phenomenon happened every few weeks when the rainy season began. No standard survey could be done under such conditions. We found few fish or aquatic organisms had survived from such a dramatic change in habitat. Soil and rocks had completely covered the original riverbed, filled up the deep pools and buried the bedrock and boulders on which the periphyton grew and which the fish usually feed.\(^2\) The fish community could easily die during the dry season, when the water level became too low and the filled-up pools could no longer provide them with shelter. It should be noted that most rivers in Taiwan do not connect with one another due to the steep topography. Sibling species or even the same species of primary freshwater fishes in different river basins are well isolated and have developed their own specific genotypes.\(^6\) If the fishes inhabiting Ta-Chia River were to die, they would become extinct and there would be no way of replacing the destroyed gene pools.

To our knowledge, this is the only report describing the impact of a catastrophic earthquake on the fish population in an independent subtropical water system. This study may provide a better understanding of the earthquake's effects on the interactions between wildlife and the changing environment.

We are grateful to Tai-Power Co. and the National Science Council for their support of this study and to LSF.

REFERENCES

2. Han CC, Tew KS, Chen IS, Su LY, Fang LS. Environmental


Fig. 2  Comparison of two endemic freshwater fish populations Zacco pachycephalus and Acrossochelius paradoxus between (□) October and December 1988–1992 (n = 45) and (■) the same months during 1999 (n = 9) in Ta-Chia River, Taiwan. Four size classes were compared (*P < 0.05, Mann–Whitney’s rank sum test). Vertical lines show SD. The two study sites, Kukuan and Tungmau revealed the same phenomenon. These two sites are separated by 10 km, where Kukuan is located at an altitude of 800 m a.s.l. and Tungmau is located 400 m a.s.l.