

Glacial Refugia, Endemism, and Stickleback Populations of the Queen Charlotte Islands, British Columbia

The biota of The Queen Charlotte Islands (53° N, 132° W) has long been recognized as distinct from that on the mainland (Dawson 1880). Endemic birds, mammals, an invertebrate, angiosperms, tracheophytes, and bryophytes have been described (Foster 1965; Bousfield 1958; Calder and Taylor 1968; Schofield *in* Calder and Taylor 1968). Recent studies reveal divergence in a fish, *Gasterosteus aculeatus* L., the threespine stickleback, as well (Moodie 1972a,b; Moodie and Reimchen 1976).

There is thus endemism in many of the major taxa (only one native amphibian is present and there are no

reptiles). Explanations for this divergence are contradictory but not necessarily mutually exclusive. Calder and Taylor (1968) and McCabe and Cowan (1945) believe refugia allowed the survival of resident populations in spite of glaciation. Others are of the opinion that some populations differentiated after deglaciation (Foster 1965).

However attractive the refugia hypothesis may be, geological evidence indicates the islands were heavily glaciated during the Wisconsin stage of the Pleistocene epoch (Sutherland Brown and Nasmith 1962). These workers describe unglaciated

areas as inhospitable habitats, less than 9.1 km² in area, at high altitudes, cold and windswept. Nevertheless, Foster (1965) maintains that several of the endemic mammals could have survived on the islands throughout their glaciation.

The purpose of this communication is to discuss previously described populations (Moodie 1972a,b; Moodie and Reimchen 1976) of *G. aculeatus* in terms of the controversy regarding postulated refugia and the origin of other endemic groups on the islands. Our past studies, although not dealing with historical aspects of stickleback evolution, do provide information pertinent to the question. We have no plans for a future biogeographical study of the origins of the endemic populations because we are not convinced a methodological approach exists that would yield results that would significantly reduce the uncertainty which inevitably characterizes conclusions concerning historical questions such as these.

Divergence in the sticklebacks is unlike that of most other groups in which endemics occur, either throughout the islands as in the case of *Euarctos americanus carlottae* (black bear) and *Martes americana neso-phila* (pine marten), or in one region, for example, the vascular plants, all of which are found in the Queen Charlotte Ranges and mountains of the Skidegate Plateau. Instead, morphologically distinct stickleback populations are often found in each lake; fish of Boulton Lake often lack the pelvic girdle, very large melanistic fish occur in Mayer Lake, and most fish in Skonun Lake lack lateral scutes (Moodie 1972b; Moodie and Reimchen 1976). The taxonomic status of these stickleback populations is undetermined, partly because the taxonomy of the parent species is unsettled (Miller and Hubbs 1969; Hagen and McPhail 1970). At least one population, however, parapatric with a form like that common on the mainland, may meet the criteria of the biologically defined species. Other populations show extremes of variation which match or exceed that known for the species over its entire and extensive range (Moodie and Reimchen 1976).

There is also a distributional contrast between the endemic fish and other groups: the most divergent stickleback populations are found in the Queen Charlotte Lowlands (Figure 1), whereas all the endemic vascular plants are confined to higher altitudes as stated above. (We must note, however, that the sampling of fish populations in these islands is far from complete.)

A pre-glacial evolution of these populations could be indicated if endemic populations occupy sites which might have escaped glaciation, if existing populations were founded by fish surviving in refugia elsewhere, or if variation among populations shows a geographic pattern reflecting possible pathways of

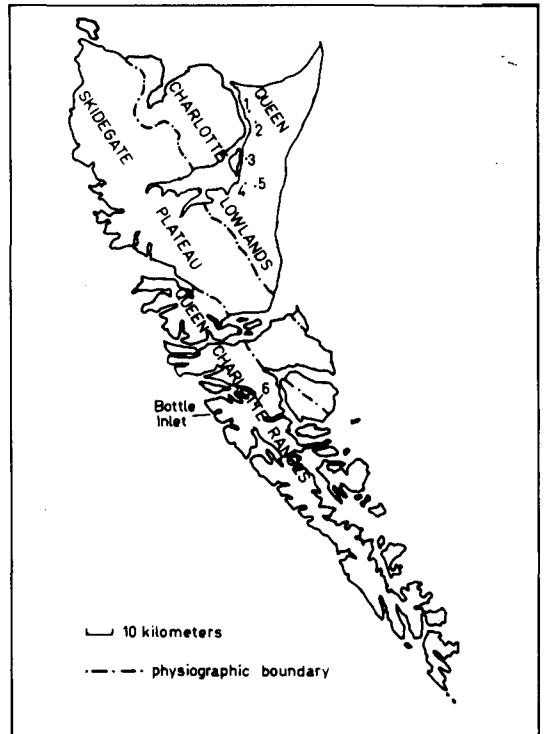


FIGURE 1. Map of the Queen Charlotte Islands, British Columbia. Lakes referred to in the text are indicated by numbers as follows: 1 Drizzle, 2 Skonun, 3 Boulton, 4 Loon, 5 Mayer, 6 Takakia.

dispersal from a refugium.

It is unlikely the divergent populations of Boulton, Mayer, Skonun, and Drizzle Lakes occupy sites which were not ice-covered. Various glacial flutings, drumlins, and evidence of an outwash plain are present in the vicinity of these lakes (Sutherland Brown 1968, Figure 2).

The possibility of fish survival elsewhere in the islands is equally remote. High mountain tops or narrow strips of land between the ice front and the sea would scarcely be suitable habitats for fish populations. At present, high lakes such as Takakia and others on the west coast between the mountains and the sea, for example, one north and another south of Bottle Inlet, apparently lack fish. Some of the variant populations phenotypically resemble distant ones on the mainland or elsewhere. Fish of Boulton Lake are in several ways similar to some on Texada Island, 658 km to the south: however, this site too was glaciated. Sticklebacks in other lakes, such as Skonun, often lack lateral plates as do some in southern California and Europe. To us it is only

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