Fig. 1.—General view of a small patch of *Phylloglossum* plants. As is normal in most populations there are many more sterile plants than fertile and a great range of sizes of plants are found. The 5-cent coin is about 2 cm in diameter and provides a convenient scale.

Phylloglossum

Miniature Denizen of the North

J. E. Braggins, Auckland

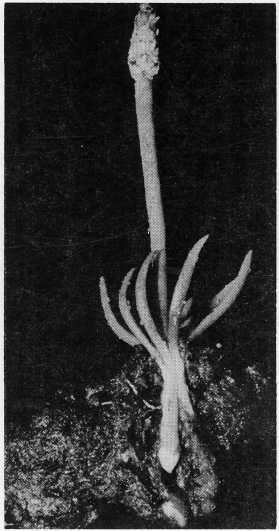
Phylloglossum drummondii, first described by Kunze, a German botanist, in 1843, is a very small plant related to the lycopodiums or club mosses. In addition to New Zealand it is found in Western Australia, Tasmania, and Victoria. There is only one species of *Phylloglossum,* and because of its small size and habit of growing in low sedge and scrub it is not often detected. Furthermore it has a short growing season when it is above ground (May–June till September–October), and few botanists know it in the field.

The description in Allan's *Flora of New Zealand* tells us that it is ". . . a plant up to 5 cm long, rarely more; leaves linear, acute, usually few, seldom more than 10, about 2 cm long". The stalk or peduncle of the fruiting part is described as 3-4 cm long, with a strobilus (sport-bearing part) about 7 mm long. The generic description having already said that the strobilus was terminal and roots scanty, we have some idea what the plant may look like, though words cannot convey adequately the appearance of this unusual little plant (Fig. 1).

In New Zealand *Phylloglossum* is often regarded as a typical kauri and burnt-over scrubland plant. Certainly this is true of much of its occurrence in North Auckland; the plant has, however, also been collected near Christchurch and in the Marlborough Sounds so it is capable of living in a fairly wide range of habitats. In the north the best areas for *Phylloglossum* are recently burnt-over scrubland usually with sparse low manuka, 6-18 ins high, with sedges. This vegetation is similar in some respects to areas in Australia which also have had repeated fires.

Because of this preference for a habitat which in New Zealand is unlikely to have been very common before human influence it is possible that *Phylloglossum* may recently have drifted as spores across the Tasman sea from Australia to colonise the newly formed suitable areas. This may perhaps have even been as recently, at a guess, as Maori times, though suitable areas for colonisation may have existed during the North's earlier volcanic history.

The first sight of the plant with bright green cylindrical leaves sticking up a short distance out of the bare soil is a real thrill, as is the first finding of any elusive plant. Others that immediately spring to mind are the adder's tongue fern *(Ophioglossum)* and its relative *Botrychium.* As with these two, once you have found the first plant a whole patch seems suddenly to have sprung up around you.



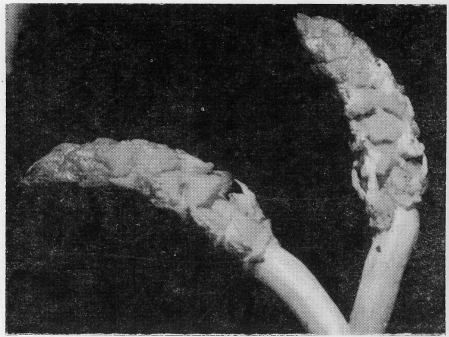


Fig. 3.—Detail of the strobilus shows the close relationship of *Phylloglossum* to the other lycopods. The sporangia are exposed as the central axis elongates from the base, separating the sporophylls (the small protective bracts). The strobili are c. 8 mm and 6 mm long respectively.

Fig. 2.—A complete *Phylloglossum* plant showing the strobilus at the tip of the peduncle (stalk) arising from the apex of the plant and surrounded by the leaves. Below the soil level the new season's tuber can be seen as it pushes down into the soil. The old tuber is duller and lies beow the white new tuber. The total length of the plant is about 4 cm.

Plants in my collection are generally 4 cm to 5 cm tall, though this may reflect a tendency to collect only large healthy plants. Striking features are the very few roots, cylindrical, rather soft looking leaves, and the very prominent new tubers (Fig. 2).

The sporophylls (leaves protecting the sporangia) are small and specialised and in the early development of the strobilus surround and cover the developing sporangia. This stage takes several months, then when they are well developed the peduncle elongates, lifting the strobilus clear of the leaves (Fig. 2). The peduncles of sheltered plants elongate much more than those in exposed places, suggesting that the elongation of the peduncle may be designed to lift the ripe spore-bearing parts up into disturbed air so that they may be better distributed. When the little cone-like strobilus ripens the axis elongates, separating the sporangia and their sporophylls from each other (Fig. 3) and thus the spore sacs soon dry out and split open, shedding the spores. The spores are quite like those of some lycopodiums.

As well as producing spores which may be spread great distances by strong winds, the plants have other means of increasing their numbers. From the centre of the plant a new tuber is produced each year, and this is pushed down into the soil by a short branch. Some plants may produce more than one tuber and thus the number of plants may gradually increase. The plants would, however, still form a close turf, as the tuber-producing branches are very short.

The tubers are pushed only a centimetre or two into the ground, but this seems sufficient protection for the plants to survive the summer drought. Though often found in clay soils the species seem equally at home in sandy soils. In fact, the largest plants I have seen were growing in sandy conditions, but their greater stature may be partly caused by the deeper shade of the taller manuka at that site.

Like most primitive plants, especially ferns, *Phylloglossum* has two stages in the life cycle. The plant as we normally know it is the sporophyte generation, and in *Phylloglossum* this is much better known than the gametophyte. The spores, which are normally produced in large numbers, do not grow directly to form miniature replicas of the plant which produced them, but instead grow to form a completely different plant — usually different not only in shape and size but also in the type of conditions it will tolerate. This plant does not produce spores but instead produces the male and female gametes and houses the developing zygote after fertilization, providing protection and initially nutrition for the young sporophyte. This new plant will eventually be the same as that which produced the spores. Thus we have 2-generation life cycle, like that found in ferns.

The gametophyte is the stage or generation produced from the spores and in *Phylloglossum* they are described as very small tuberous bodies with a crown at the upper end on which the sexual organs are borne. Older gametophytes in which an embryo has been formed are more irregular in form. The crown, which may be conical, rounded or projecting to one side, is commonly separated by a slight constriction from the much enlarged body of the gametophyte. Below this swollen part the body contracts again into a cylindrical shaft which passes downwards to swell out again and terminate in the primary tubercle. The shaft is the portion that varies most; short gametophytes may be 2 mm long while others range up to three times this size according to the length of the shaft.

The whole upper part of the gametophyte is green, especially just below the crown, but less and less so deeper in the soil. The gametophytes are probably similar to those of *Botrychium* and some species of *Lycopodium* which are small, wholly or partly buried and quite difficult to locate. It certainly seems possible that they are more widespread than is generally conceded.

If *Phylloglossum* is spread mainly by its spores then we would expect gametophytes to be fairly common in suitable sites. They may in fact be common but there are very few reports of their being found. Professor A. P. W. Thomas (1901) found quite a few from three localities, but they were nearly all lost and published descriptions are brief. This lack of information about the gameophytes may be partly because of the notorious difficulty of finding small subterraneous forms, or it may reflect a real lack of gametophytes, the plants being spread mainly by the production of new tubers. Though vegetative spread may be reasonable in very small populations it seems unlikely to be true for larger ones, especially as the plants seem to die out fairly soon once they become shaded by taller vegetation.

This has happened at Waikumete Cemetery near Auckland in recent years. The colony was well known and the area was repeatedly searched for gametophytes by a research student but none were found. Professor Millener, who supervised this work, agrees that it seems impossible for the plant to have any long-range dispersal other than by spores, which automatically implies the presence of gametophytes in at least the early stages of the colony. The manuka scrub in this area is now 6 ft tall and in the last three seasons only a single plant has been found. Now the population seems to be extinct.

Why are botanists so interested in *Phylloglossum*? It is obvious that its small size and ephemeral nature are not in themselves sufficient to cause all the interest in this small plant. If we check in botanical text books we find that *Phylloglossum* has played a major role in some botanical theories, in particular the protocorm theory.

The chief exponent of this theory was a German, Treub, and it was widely accepted late last century.

Some lycopodiums pass through an undifferentiated stage of growth early in their development, then begin organised growth by producing a few simple leaves. Treub believed the protocorm to be the fore-runner of the true leafy shoot and regarded all lycopods as primitive, those with a protocorm stage as the most primitive of all.

Phylloglossum was thought to be a permanent protocorm, and thus the key stage in plant development. Today *Phylloglossum* is regarded as a specialised advanced and reduced form and its tubers are regarded as a response to the extreme environment in which the plants live, i.e. winter rainfall and prolonged summer drought. An interesting point is that Holloway (1916) found that the three N.Z. species of *Lycopodium* conspicuous in forming protocorms *(L. cernuum, L. ramulosum* and *L. laterale)* all have green, short-lived gametophytes and all grow in places that are subject to summer drought — the main difference being that in *Phylloglossum* the sporophyte has a short life (or at least its above-ground portions do). Two other plants which I have found in the four *Phylloglossum* areas I have visited also develop tubers. Both are leafy liverworts, and one of them is the large and beautifully ciliate *Goebelobryum* which is also common in the Waikato swamps. (Another plant from the Waikato swamps which is also found in *Phylloglossum* country is the very rare *Lycopodium serpentinum* recently rediscovered in N. Auckland by the eagle eyes of local botanist Joe Rawlings.)

The restriction of *Phylloglossum* to a habitat dependent on fairly regular fires may at some future date make it a rare species, as gradually more and more of the marginal scrubland is brought into productive pasture and the wilderness areas become better protected as reserves. The main danger at present is that we know little of the ecology of this plant or its requirements for development and multiplication. The records we have are scanty, and it has already vanished from several areas near Auckland.

All records of populations of any size are of interest in tracing the changing pattern of distribution, and even the report of a small population may help to locate a new colony or re-establish the existence of a known one; of particular interest are reports of colonies in recently burnt areas as these may be new colonies. As I have already pointed out the plant is very ephemeral, and though above ground from about May till October it is most easily found in late August or early September, when the fertile stalk is at its tallest.

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The Hukutaia Domain, Opotiki

Museum of the New Zealand Flora

M. Heginbotham, Opotiki

THE Hukutaia Domain contains one of the finest living collections of the New Zealand flora available to the public. It represents over 35 years of continuous interest, loving care and labour by Norman Potts, one of our most eminent amateur botanists and well known to many throughout the country until his death in November 1970. Hukutaia offers bush walks through magnificent forest settings, splendid specimen plantings of trees, shrubs and ferns (many rare), rock gardens with alpine plants and a parkland full of interest, all of indigenous plants only.

Situated about 4½ miles from Opotiki, the Domain of 11½ acres overlooks the Waioeka R. valley with the Borough, the Pacific Ocean and White Island clearly visible to the north. Following the signposts, one keeps left after crossing the Waioeka bridge from Opotiki, and gradually climbs the several hundred feet along Woodlands Road almost to its end. To the east and south a backdrop of bush-clad hills and mountains completes the picture. The Domain lies on the 38th parallel and experiences climatic conditions ranging from 90° in summer to about 10° of frost in winter, with rainfall normally between 50-60 inches p.a.

In 1918 the Woodlands Estate of about 2000 acres, bordering the Waioeka R. to the west of Opotiki, was sold to the Government by Mr Hutchinson of Gisborne for Rehab. farms for ex-servicemen of World War I. In the course of subdivision a stand of native bush containing a giant puriri estimated to be at least 2500 years old so impressed the surveyor, Mr P. W. Barlow, that he suggested the area be retained as a reserve. This was agreed to, and the reserve was left in the hands of the County Council. Soon after, when one of the settlers wanted control over the reserve area, the remaining Woodlands settlers banded together to form a Domain committee, and voluntarily raised money to fence the area to exclude stock, which up till then had roamed there at will. The huge