CORREGENDUM TO *AN ECOLOGICAL APPROACH TO NEW ZEALAND'S FUTURE*

Dr R.A. Fordham
Dept of Botany
Massey University
PALMERSTON NORTH

Dear Sir,

We have recently read *An ecological approach to New Zealand's future,* Supplement to vol. 21 of the Proceedings of the New Zealand Ecological Society. Being engaged in forest and soils research we feel that we have some responsibility in this field and would therefore like to draw the following points to your attention:

1. Figure 2 is presented as representing "a typical New Zealand forest soil". To us this is very misleading; our reasons for saying this are —
   a. By using *concentrates* of plant nutrients rather than *total amounts* (the latter would take into account the large difference between the bulk densities of soil and leaf litter) a false impression is given of the distribution of nutrients between the litter and the soil.
   b. This false impression is made even more unrealistic in that the nutrients in the litter are 'totals' while those in the soil are 'exchangeable'. The total quantity of a nutrient in a soil can be 100 times the exchangeable and at least some of the non-exchangeable is utilisable by plants — particularly trees.
   c. The above two points apart we do not feel that "a typical New Zealand forest soil" can be synthesised from two soils on the hills adjoining the Hutt Valley and one in the extreme southeast of Southland. For example, one soil is reported, in the references referred to, as having no litter, one had ½ in. and the third had 19½ in. These have been combined to give a 'typical' depth of 20cm. We can follow neither the logic nor the mathematics of this.
2. Figure 3 is based on Likens *et al.* (1970, the data in which must be the most misapplied in recent ecological literature. The fact that after clear-felling the experimental area was kept free of vegetation by repeated herbicide applications makes this a study of extreme conditions which do not apply in normal practice.

   In the same area it has been shown that under revegetation the position is quite different (Marks and Bormann, 1971, *Science 176:* 914-5). Douglass and Swank (1972, USDA For.Serv.Res.Paper SE 94) state "Countrary to the findings at Hubbard Brook, the results of experimental treatments at Coweeta have not shown an accelerated loss of ions to the streams". Reinhart (1973, USDA For.Serv.Res.Note SE 170) concludes "Nutrient losses following clear cutting in the central and southern Appalachians appear to be negligible. The differences between the New Hampshire (Hubbard Brook) and other results seems to be associated with the nature of podzol soils". Also Weisel and Newell (1970, Mont.Forest and Conserv. Exp.Sta.Bull.38) report no measurable nitrate in two streams in which a third to a half of the watershed had been logged and downstream in the Blackfoot river the maximum nitrate concentration was less than 1/100 of that found after defoliation at Hubbard Brook.

In raising these points we do not imply that we disagree with the conclusions or recommendations of this report. On the other hand we feel that careless and misleading presentation of data in a document of such potential importance weakens the arguments and does no credit to the society which the authors represent.

Yours sincerely,

(Ruth L. Gadgil)

(D.J. Mead)

(P.J. Knight)

(G.M.Will)
for E.H. Bunn (Director)
Production Forestry Division
Forest Research Institute
New Zealand Forest Service

The following correspondence provides the background to publication of a revision of the caption to Figure 2 of *An ecological approach to New Zealand's future:*

The Director,
Forest Research Institute,
Production Forestry Division,
Private Bag,
Rotorua,
NEW ZEALAND.

Dear Sir,

Thank you for you comments on Figs. 2 and 3 in *An Ecological Approach to New Zealand's Future.* I was entirely responsible for the production of both figures and legends. Both were discussed with members of the Soil Science Department at Massey University and with staff and the Soil Bureau, at Lower Hutt and I was well aware of the element of subjectivity involved in the production of Fig. 2.

It is difficult to produce generalisations documented to satisfy the critical scientist and at the same time easily read and grasped by the layman. Easy reading was an important consideration — our paper is not intended primarily for ecologists. This, of course, is no excuse for errors of fact, or for deliberate misrepresentation of fact, or for carelessness. However, your letter does not correct any errors, rather it objects to a "false impression" and accuses us of "careless and misleading presentation of data". Your view, I think, is that Fig. 2 is a generalisation from inadequate data, and therefore you consider the use of the word "typical" as unjustified. Your statement that the diagram "gives a false impression" suggest that you have data from which you have gained a "true impression" of the nutrient distribution in the profile of a typical New Zealand forest soil. If you do I would be interested to see them, and would regard this as constructive criticism. If not, then we are dealing with matters of opinion, not fact.

The impression that Fig. 2 is intended to give is that in general, in soils developed under climax forest in humid or sub-humid climates, most of the available plant nutrients are concentrated in the upper layers of the soil and in the litter. Not-with-standing the fact that some elements may become concentrated in illuvial horizons deeper in the profile, I regard this as a broad generalisation applicable to climax forest ecosystems in New Zealand and elsewhere. For example, Wilde (1958, p. 240) presents data from "typical profiles of forest soils" which all show maximum cation exchange capacities in the A_{00} and A_0 horizons. Although I was, and still am, unable to find a good example of cation concentrations in forest profiles with litter, almost all standard texts (eg. Black 1968; Bear 1964; Lutz and Chandler 1946) and review papers (eg. Ovington 1962; Bray and Gorham 1964) stress both the importance of organic matter as a nutrient source and retainer, *and* its concentrations near the surface in forest soils. The remarks and references given in the paper by Charley and Cowling (1968) mentioned in the legend to Fig. 2 are also relevant: "It is a characteristic of many ecosystems that much of the biologically mobile nitrogen and phosphorus capital is concentrated towards the soil surface."

I know that my generalisation does not invariably apply and we do not suggest that it does. If the point was to be made diagrammatically then the alternative to the sort of generalisation attempted was to produce a whole set of soil profile diagrams e.g. Figs. 7.3.1 to 7.3.8 in N.Z. Soil Bureau Bull. 26(2), and this was considered and rejected on the grounds that it would place too much emphasis on one small point.

I entirely agree that a typical New Zealand soil cannot be synthesised from Judgeford silt loam, Taita clay loam and Tautuku silt loam. I have not done so; the legend clearly names these as examples only. Many more data were plotted before the generalised profile was drawn. Zonal Yellow Brown Earths are by far the most widespread soils in New Zealand (approx. 9.5 million acres). Formerly almost all these soils in New Zealand were covered with forest (Pool, A.L. in Bulletin 26(1) p.96F.) which was predominantly of the 'Mixed-Podocarp' type on lowlands and medium elevation hill country (Taylor, N.H., Pohlen, I.J., & Scott, R.H. in Bulletin 26(1), Fig. 4.1 — see also description of 'Native vegetation' given for individual Y.B.Es in Vol. 3). I conclude that Yellow Brown Earths are typical New Zealand soils, and that they were usually developed under a Mixed-Podocarp forest cover. Fig. 2 is thus an attempt to reconstruct a profile in which the litter layer has largely disappeared with forest clearance. Of the 54 soils described in Bulletin 26(3) only three carry forest vegetation native to the site. One of these is an intra-zonal soil and its vegetation includes exotics (Rotomahana Sandy Loam). The other two carry much less modified forest, and both these have deep litter layers (c.20"). One is a Northern Podzol under Kauri (Wharekohe) and the other (Tautuku) a Podzolized Southern Yellow Brown Earth. The latter carries Kamahi-Rimu forest which is a Mixed Podocarp forest typical of the wetter Yellow Brown Earths.

If the diagrams for Y.B.Es given in Bulletin 26(2) Gis. 7.3.1 to 7.3.8 are examined, it is apparent that they *all* show maximum cation concentrations in the upper layers (Puketeraki, Mangaweka, Belmont, Judgeford, Waikiwi, Puhoi and Waikare). Litter is not recorded for any of these profiles and none of them was taken under native forest. If the Y.B.Es for which litter data are available (Taita, Tautuku and Tekapo in Bulletin 26 and Miller and Hurst (1957) are similarly plotted rather similar curves result. (It might be argued that the upper part of the curve in Fig. 2 should be displaced a few milliequivalents to the left but that is splitting hairs). Disregarding the problems associated with the litter for a moment, the curve I have drawn for the *soil* component is thus an approximation to data from 10 Yellow Brown Earths from scattered locations in New Zealand. In this respect I regard it as 'typical of New Zealand forest soils'. (It is not valid to simply average the data as they are based on different sampling depths).

I was aware that the data given for litter concentrations in Bulletin 26 are difficult to compare with the soil data because of the different bulk densities involved, and because the litter data are 'totals' not 'exchangeable'. I now realise that my attempt to keep the legend as brief and uncomplicated as possible may have given a spurious impression of accuracy. I had assumed that the adjective 'generalised' would prevent this. Soil Bureau have no data on 'total amounts' in soil and litter at any one place and they cannot be derived from the results in Bulletin 26 (Molloy, L.F., pers. comm.). The concept of exchangeability cannot be easily applied to the litter; biologically important are rates of input and decomposition of organic matter. As the nutrients are leached in rainwater and released by decomposition they enter the 'available' pool, at least temporarily, so that in this sense probably at least 50% of the 'total' nutrients in the current litter fall become available for uptake by plant roots in any given year. (See, e.g., Rodin and Bazilevich, 1967; Thomas, 1969; Ovington, 1962; Edwards and Heath, 1963; Will, 1967).In a steady-state situation the total annual nutrient input in litter will be balanced by an equivalent release into the available pool in the soil surface. The 'total nutrients' in the litter become exchangeable in a much shorter time-span than is usually the case in soil.

Having said this I accept your criticisms 1(a) and 1(b) in-so-far-as the diagram might over-emphasise the concentration of nutrients in the litter, though not its importance in soil genesis and nutrient dynamics (see Wilde, p.99). Litter depth is derived from the two forest profiles already mentioned (20") and my own experience in Mixed Podocarp forests in the central and southern North Island. The other litter data given in Bulletin 26 are inadequate as the litters involved are not derived from the vegetation originally associated with the soil. The curve is drawn through the litter on the basis of the total values given for the surface layer in the Kaingaroa, Taita, Tekapo and Okaihau soils in Bulletin 26(3), the data in Miller and Hurst (1957), and the general trend to decreasing cation content with depth shown in the Tautauku and Wharekohe litter.

In view of your criticisms I have forwarded the enclosed corrrection for posting with all subsequently distributed copies of the paper. It is to be hoped that the difficulties I experienced in trying to piece together a realistic 'average' situation describing the forest soils on New Zealand, particularly of the lowland forest from which our agricultural and grazing lands have been derived, will stimulate more research into the few remaining areas of undisturbed Mixed Podocarp Forest in the lowlands.

Your criticism of Fig. 3 is certainly a matter of opinion. I agree with you that it is a pity that the Hubbard Brook work has been so widely quoted, with very little criticism, and that is has got into text books. It is never-the-less the most comprehensive study of its kind so far published and readily available, so that the reader can form an independent opinion. It seems quite possible that further studies will show that the Hubbard Brook nutrient losses were extreme, and related more to the subsequent treatment than to the initial felling, but it seems highly improbably that the whole of the nutrient loss can be accounted for in this way. The authors state quite unequivocally: "The action of the herbicide in the cutover watershed seems to be one of reinforcing the already well established trend, of loss of NO3, induced by cutting alone" and "Beginning on 7 June 1966, 16 days before application of the herbicide, nitrate concentrations in W-2 show a precipitous rise, while the undisturbed ecosystem shows the normal late-spring decline" (Bormann *et al.*, 1968). Later in the same paper and subsequently (Likens *et al.*, 1969) they demonstrate that nitrate loss is associated with loss of cations. While Marks and Bormann (1971) show that rapid natural regrowth after felling operates to minimise nutrient losses they also stress that "silvicultural practice that ignores the function of successional **unsound". In any case, *some* use of herbicides in such situations is normal practice in New Zealand if we are to believe the anonymous Environmental Impact Report on the utilisation of South Island Forests (p. 18; 7.11 and 7.12).**

I do not conceed that I have in any sense "misapplied" Fig. 3. As with so many other points made in the paper, a fuller discussion would have to include contrary evidence and different opinions, but we were at pains to keep the text as brief as possible. I would point out that the relevant text reads "Loss of nutrients from a catchment is related to plant cover and water run-off, so the destruction of vegetation, or its replacement by vegetation with poorer water-holding capacity (for example, replacing forest by grassland), *can* result in an increased loss of nutrients". Fig. 3 is an example of a situation in which it did. White's work on the Taita catchments is quoted as further substantiation of the statement.

In summary: I appreciate your misgivings over Fig. 2, and acknowledge the validity of criticisms 1(a) and 1(b). However, for the general reader the diagram will simply illustrate that removal of the litter and top-soil can remove a large proportion of the nutrient capital. Criticism 1(c) is a result of misunderstanding of the legend, and criticism 2 is a moot point.

Yours sincerely,
Dr. John Ogden.

REFERENCES

BEAR, F.E. (1964) *Chemistry of the Soil* (2nd Edition) Reinhold Monograph Series No. 160.

BLACK, C.A. (1968) *Soil Plant Relationships* (2nd Edition). John Wiley and Sons Inc., New York, London, Sydney.

BORMAN, F.H., LIKENS, G.E., FISHER, D.W. & PIERCE R.S. (1968) Nutrient loss accelerated by clear-cutting a forest catchment. *Science, 159* : 882-884.

BRAY, J.R. & GORHAM, E(1964) Litter production in forests of the world. *Adv. Ecol. Res, 2* : 101-157.

CHARLEY, J.L. & COWLING, W.W. (1968) Changes in soil nutrient status resulting from over-grazing and their consequences in plant communities of semi-arid areas. *Proc. Ecol. Soc. Australia, 3* 28-38.

EDWARDS, C.A. & HEATH, G.W. (1963) The role of soil animals in break-down of leaf material. *In* : *Soil Organisms.* Edited by J. Doeksen and J. Van Der Drift. North Holland Publishing Co., Amsterdam.

LIKENS, G.E., BORMANN, F.H. & JOHNSON, N.M. (1069) Nutrification : Importance to nutrient losses from a cutover forested ecosystem. *Science, 163* : 1205-1206.

LUTZ, H.J. & CHANDLER, R.F. (1946) *Forest Soils* John Wiley and Sons Inc., New York.

MARKS, P.L. & BORMAN, F.H. (1971) Revegetation following forest cutting: Mechanisms for return to steady state nutrient cycling. *Science, 176* : 914-915.

WILL, G.M. (1967) Decomposition of *Pinus radiata* litter on the forest floor I Changes in dry matter and nutrient content. *N.Z. Jl. Sci. 10.* (4) 1030-1044.

MILLER, R.B. & HURST, F.B. (1957) The quantity and nutrient content of Hard Beech litter. *N.Z. For. Res. Notes. No. 8* 14 pp.

New Zealand Soil Bureau Bulletin 26 (3 volumes). (Various authors).

OVINGTON, J.D. (1962) Quantitative ecology and the woodland ecosystem concept. *Adv. Ecol. Res., 1* : 103-192.

RODIN, L.E. & BAZILEVICH, N.I. (1967) *Production and mineral cycling in terrestrial vegetation.* Oliver and Boyd. Edinburgh. 288pp.

THOMAS, W.A. (1969) Accumulation and cycling of Calcuim by Dogwood Trees. *Ecol. Monog. 39* : 101-120.

WHITE, E (1972) The distribution and movement of "reactive" phosphorus through catchments under varied land use. *Proc. N.Z. Ecol. Soc. 19: 163-172.*

WILD, S.A. (1958) *Forest Soils.* The Ronald Press Company. New York. pp 537.

CORRIGENDUM

The legend to Figure 2 should read :

Hypothetical profile of a typical New Zealand forest soil before forest clearance. Note that figure is based on concentrations not total quantities never the less removal of surface litter and the top few cm of soil may remove the majority of plant nutrients. Based on data for 'yellow brown earths' given in *N.Z. Soil Bureau Bull. 26* (1968) Soils of New Zealand Part 3 (e.g., Judgeford silt loam, Taita clay loam, Tautuku silt loam) and Part 2 (e.g. Fig. 7.3.2). The concentration in the litter is based on total cations, while that in the soil is based on exchangeable cations. Litter depth varies greatly between forest types and that shown is probably maximum. See also Charley, J.L., & Cowling, S.W. (1968). Changes in soil nutrient status resulting from overgrazing and their consequences in plant communities of a semi-arid area. *Proceedings of the Ecological Society of Australia, 3 : 28-38.*