explained the shift of N–O frequency to higher region on the basis of the contribution of polar structure of the ligand. The metal-nitrogen and metal-oxygen stretching vibrations have been recorded at 520 and 580 cm^{-1} respectively.

Thus it is clear that on chelation hydrogen of hydroxyl group is replaced and nitrogen of oximino group donates a lone pair of electron to the metal ion.

Electronic Spectra

The ground state for the low spin complexes of d^8 configuration is

$$[a_{1g}(z^2)]^2\,[e_g(xy, yz)]^4\,[b_{2g}(xy)]^2 \equiv {}^1A_{1g}$$

and are diamagnetic. The present DCHAO complex is also diamagnetic in nature. Three spin allowed *d-d* transitions are anticipated corresponding to transitions from the three lower lying *d*-levels to the empty $d_{x^2-y^2}$ orbital; two electron transitions would be very weak and neglected. Energies corresponding to these transitions are determined from the following equations[11]:

$$d_{xy}(b_{2g}) \longrightarrow d_{x^2-y^2}(b_{1g})\,E\,({}^1A_{1g} \longrightarrow {}^1A_{2g})$$
$$= \Delta_1 - C$$
$$d_{xy,\,yz}(e_g) \longrightarrow d_{x^2-y^2}(b_{1g})\,E\,({}^1A_{1g} \longrightarrow {}^1E_g)$$
$$= \Delta_1 + \Delta_2 - (3B + C)$$
$$d_{z^2} \longrightarrow d_{x^2-y^2}(b_{1g})\,E\,({}^1A_{1g} \longrightarrow {}^1B_{1g})$$
$$= \Delta_1 + \Delta_2 + \Delta_3 - (4B + C)$$

Only two bands at 32010 cm^{-1} and 44500 cm^{-1} have been observed in the electronic spectra of Pd $(C_8H_6NO_2Cl_2)_2$. Following the assignment of Mason and Gray[12], on the electronic spectra of the square planer $[Pd(NH_3)_4]^{+2}$ complex, we may presume that the former one is a combination of all the three spin allowed transitions. This means that in the case of Pd (II), complex, the values of ligand field parameters Δ_1, Δ_2 and Δ_3 derived from the *d-d* spectra of Pd (II) complex were found 35510, 1500 and 500 (in cm^{-1}) respectively taking B = 500 cm^{-1}, C = 3500 cm^{-1}. The other band at 44500 cm^{-1} is due to the ${}^1A_{1g} \rightarrow C^1Eu$ transition[13].

ACKNOWLEDGEMENT

The authors wish to express their grateful thanks to Dr. Nitya Nand, Director, C.D.R.I., Lucknow, for I.R. spectra.

1. Poddar, S. N., *Z. Analyt. Chem.*, 1957, 154, 254; 1957, 155, 327; *Anal. Chem. Acta*, 1963, 28, 586; *Ind. J. Chem.*, 1963, 1, 496; 537.
2. Gupta, B. D. and Malik, W. U., *Ind. J. Chem.*, 1969, 7, 724; 922.
3. Prakash, S., Dutt, Y. and Singh, R. P., *Ibid.*, 1968, 6, 664.
4. Shah, J. R. and Patel, R. P., *J. Ind. Chem. Soc.*, 1971, 48, 169; 1177.
5. Gupta, S. P., Srivastava, S. K. and Lal, K, *Ind. J. Chem.*, 1975, 13, 297.
6. Lal, K. and Gupta, S. P., *Curr. Sci.*, 1975, 44, 178.
7. — and —, *Ind. J. Chem.* (in press).
8. Fenger, J., Siekieska, K. E. and Jensen, B. S., *J. Inorg. Nucl. Chem.*, 1971, 33, 4366.
9. Ramaswamy, K. K., Jose, C. I. and Sen, D. N., *Ind. J. Chem.*, 1967, 5, 156.
10. Blinc, R. and Hadzi, D., *J. Chem. Soc.*, 1958, p. 4536.
11. Martell, A. E., *Coordination Chemistry*, Van Nostrand-Reinhold, New York, 1971, 1, 67.
12. Mason, W. R. and Gray, H. B., *J. Am. Chem. Soc.*, 1968, 90, 5721.
13. — and —, *Inorg. Chem.*, 1968, 7, 55.

A SIMPLE AND ELEGANT TECHNIQUE TO ASCERTAIN FOOD ACCEPTABILITY AND MIGRATORY HABITS OF EARTHWORMS

J. V. BHAT, UMA BAI AND K. SUBBANNAYYA

ICAR Project, Kasturba Medical College, Manipal

LITERATURE survey reveals that earthworms can use a wide variety of organic materials for their nutrition and propagation. The author and his colleagues had maintained in the laboratory colonies of earthworms for many years on a mixture of hay, weeds, kitchen waste and compost (which included animal dung)[1]. Evans and Guild[2] reported that earthworms produced more cocoons when fed on decaying animal products than those fed on plant materials. That earthworms can thrive well on animal dung has been known for a long time[3,4]. In fact, cowdung has been observed to be superior to kitchen waste, straw, green manure, or even a mixture of all the four for the propagation of earthworms as well as from the point of view of increase in azotobacterial population, the latter being of presumable importance for the fixation of nitrogen in soil[4].

Mention may be made in this context that Darwin[5] had reported on the behaviour of earthworms in relation to their selection of leaves for food as well as the manner in which the selected leaves get pulled to their burrows. It is known that earthworm can distinguish between different kinds of plant litter and that they even show preference for particular shapes[5], leaf species[6], and for those species which are rich in protein[7]. From the experimental evidence it would appear that earthworms do react fairly strongly to chemical stimuli as such. In other words, their food preference is dependent on chemoreception.

The present investigation was undertaken with a view to ascertaining which of the plant leaves available in abundance in this region can serve as suitable feed material for the earthworm and to make sure if the animal would prefer foliage to cowdung which had previously been established as an adequate diet.

The technique evolved, after several experimentations, proved to be simple and elegant and is presented here.

Experimental and Results

The acceptability or otherwise of foliage was tested in trays measuring 39 cm long, 28 cm wide and 6 cm deep. These trays have been found satisfactory for maintaining colonies of earthworms in the laboratory for months together and/or studying their population dynamics or for other investigations. Also, clean sand has been found to be a suitable medium to mix with dietary materials for carrying out nutritional experiments on this animal.

For the present experiment, each tray was marked into three portions, 13×28 cm each. At one end portion was maintained a colony of earthworms (*Pheretima* species) raised in the local soil as the habitat and cowdung as the feed material. The feed was given only once at the commencement of the experiment. The other end portion of the tray was filled with clean sand collected from the sea-shore and in it were layered the leaves to be tested for their suitability or otherwise as the diet. With tap water, the soil at one end and sand at the other were levelled and smoothened at surfaces with glass slide and left overnight.

The following day the activity of the earthworms overnight could be discerned from their burrows and castings thrown on the surface. The number of worms in the original colony and the number which had migrated into the sand bed was counted, whenever any migration had occurred. Leaves from the sand bed were then individually and carefully examined to note down the part or parts of the leaves nibbled at by the worms. All the worms from the sand were again transferred into the original colony. At the end of the day, the soil bed at one end and the sand bed at the other layered with leaves were again levelled with water and left overnight for earthworms to migrate. The following day the numbers migrated were again counted and the experiment thus continued with periodic migratory records for nearly seven weeks. In this way, not only their migratory habits towards preferable or otherwise foods, or adherence to the available food—cowdung—in their resident colony were recorded.

It was interesting to note that in certain instances the worms did not migrate at all, whereas in others, they exhibited their preference for the foliar diet most eloquently. In the following table, by no means comprehensive or complete, are presented some of the typical results recorded for only eight of the several plant species foliage put to the test.

Table I

Acceptability or otherwise of foliage by earthworms

Plant leaf used	No. of worms in the parent colony	No. of worms migrated after days						
		6	9	11	16	29	34	36
Eugenia corymbosa	40	12	10	13	9	10	..	..
Colacasia antiquorum	20	..	11	15	..	..	..	..
Jatropa curcus	149	9	50	52	60	66	..	60
Eugenia jambolana	22	..	..	..	..	..	..	3
Cassia tora	32	3	3	4	1	15	9	12
Polyalthia longifolia	22	..	..	..	..	..	..	..
Achras sapota	111	20	10	20	27	..	..	..
Psidium guajava	20	..	..	..	..	2	3	..

The observation that for as many as five days, the worms did not migrate from the parent colony towards the foliar diet is suggestive of the adequacy of available food in the parent colony itself. Cowdung diet was, it may be recalled, supplied only once at the commencement of the experiment. Thus, after five days partly due to the diminishing food supply in the colony and perhaps partly due to chemoreception, their migration (towards foliage supplied) became observable. Preference for foliar diet is, it may be pointed out, dependent on chemoreception and the presence of polyphenols and alkaloids components therein which markedly influence the preference or otherwise[7,8] by the worms. This was clearly evidenced in this as well as other experiments carried out. For example, mango leaf (*Mangifera indica*) is not acceptable at all to the worms in either fresh or partly decomposed state. In fact, the worms died when attempts were made (unpublished data) to grow them in a diet solely comprised of mango leaf, whereas the worms thrived very well on other foliar diets, *e.g.*, in partly decomposed guava leaves. On the other hand, as may be seen from the above results, *P. guajava* leaves do not attract them for as long as a month and, what is more interesting, even after a few had migrated, the leaves were not nibbled at, by the animals.

It is also clear from the above results that *Polyalthia longifolia* leaves were not acceptable as no worm ever migrated towards them for as long as 36 days. *Cassia tora* leaves, on the other hand, were observed to be a preferred food whether in fresh state or after partial decomposition. *Jatropa curcas* foliage also was an acceptable diet. *Eugenia jambolana* did not prove to be attractive enough, as the worms failed to migrate to them for several days. Even when they did, only a small number migrated. However, they nibbled at the food, perhaps reluctantly. Their attraction towards *Colocasia antiquorum* was for a short period.

The above experiment thus provided an easy means of detecting acceptability or otherwise of foliage by the experimental animal—earthworms.

ACKNOWLEDGEMENTS

The authors are grateful to Indian Council of Agricultural Research, New Delhi, for the Project, to Mr. T. Ramesh U. Pai, of the Academy of General Education, and Dr. A. Krishna Rao, Dean of the Kasturba Medical College, Manipal, for their keen interest and facilities, and to Miss Sumithra Thakur for technical assistance.

1. Bhat, J. V. and Khambata, S. R., *The Survey of the Microflora of Soils in Relation to Their Structure and the Role of Earthworms in Alteration of Microflora of Soils*, Final Report submitted to Indian Council of Agricultural Research, New Delhi, 1957.
2. Evans, A. C. and Guild, W. J. Mc. L., *Ann. appl. Biol.*, 1948, 35, 471.
3. Guild, W. J. Mc. L., *Soil Zoology*, Edited by D. K. Mc. E. Kevan, Butterworths, London, 1955, p. 83.
4. Bhat, J. V., *Curr. Sci.*, 1974, 43, 266.
5. Darwin, C., *The Formation of Vegetable Mould through the Action of Worms, with Observation on Their Habits*, Murray, London, 1881.
6. Satchell, J. E. and Lowe, D. G., *Progress in Soil Biology*, Edited by Graf, O. and Satchell, J. E., North Holland Publishing Co., Amsterdam, 1967, p. 102.
7. Wittich, W., *Schrift Reihe Forstl. Fak. Univ.*, Gottingen, 1953, 9, 7.
8. Mangold, O., *Zool. Jb. Abt. Allgem. Zool. Physiol. Tiere*, 1953, 63, 501.