females lost their own young when committing infanticide elsewhere and two more lost theirs while visiting burrows where infanticide had recently occurred. Given these costs, infanticide is most likely to pay dividends if it involves nearby burrows. The problem is that nearby burrows are usually occupied by close relatives. Prairie dogs group into coteries, consisiting of female kin with an unrelated adult male. All members of the coterie defend their territory against invasion from outsiders. Attacks on distant burrows occupied by non-relatives therefore entail greater risk in both time (absence from own burrows) and danger, since a foreign coterie's defences have to be breached, as well as those of an individual burrow. Possibly, the extra benefits in genetic terms may not be worth the extra costs. □

1. Hoogland, J.L. *Science* **230**, 1037 (1985).
2. Lorenz, K. *On Aggression* (Harcourt, Brace & World, 1966).
3. Calhoun, J.B. *Sci. Am.* **206**, 139 (1962).
4. Packer, C.R. & Pusey, A.E. in *Infanticide* (eds Hausfater, G. & Hrdy, S.B.) 31 (Aldine, 1984).
5. Hrdy, S.B. *Folia Primat.* **22**, 19 (1974).
6. Hrdy, S.B. *Ethol. Sociobiol.* **1**, 13 (1979).
7. Hausfater, G. & Hrdy, S.B. (eds) *Infanticide* (Aldine, 1984).
8. Jones, J.S. *Nature News and Views* **299**, 202 (1982).
9. Sherman, P. in *Natural Selection and Social Behavior* (eds Alexander, R.D. & Tinkle, D.W.) 311 (Chiron, 1981).

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Charles F. Richter (1900–1985)

Charles Richter, co-developer of the earthquake magnitude scale which bears his name, died on 30 September, 1985. He lived in California most of his life and that is where he developed his fascination with earthquakes during the embryo stages of the new science of seismology. In 1927, at Robert A. Millikan's request, he accepted a position as a physicist at the newly established Seismological Laboratory which was later to become part of the California Institute of Technology. During the 1930s he collaborated with Beno Gutenberg on a series of seminal publications entitled *On Seismic Waves* published between 1934 and 1939 in *Beiträge zur Geophysik*. These studies laid the ground work for modern observational seismology and resulted in the first detailed models of the mantle and core.

This collaboration also led to various earthquake magnitude scales and to the first complete compilation of earthquakes, published as *The Seismicity of the Earth* in 1954. Richter's book *Elementary Seismology*, which appeared in 1958, is an encyclopedia of earthquake information and is still widely used. Don Anderson

Neuroanatomy

Antibodies to acetylcholine at last

from Felix Eckenstein

In a recent publication, M. Geffard and colleagues describe the production of antibodies to the neurotransmitter acetylcholine (ACh) and the successful use of these antibodies for the immunohistochemical localization of ACh[1]. This is a remarkable breakthrough in the effort to identify cholinergic structures in the nervous system; the more so as it has been held for a long time that ACh cannot be fixed in tissue, so that the molecule cannot be localized *in situ*. Geffard *et al.* have overcome this problem by using an ingenious way to modify ACh chemically within the tissue to a form that can be fixed and localized by antibodies prepared against ACh that has been modified in a similar way *in vitro*.

Acetylcholine was one of the first neurotransmitters to be described and the vertebrate neuromuscular junction, the classical example of a cholinergic synapse, is probably the system where the physiology of synaptic transmission has been studied in most detail. But our understanding of the systems of neurones in the central nervous system that use ACh as a transmitter is much more limited. The work of Geffard *et al.* adds an important new method to those already used for the anatomical identification of neurones that use ACh as their transmitter.

Up to now, the methods for the anatomical identification of cholinergic neurones have included the histochemical localization of acetylcholinesterase (AChE), the enzyme involved in the hydrolysis of ACh[2,3]; immunohistochemical localization of the enzyme for synthesizing ACh, choline acetyltransferase (ChAT)[4-6]; or dry autoradiography to localize sodium-dependent high-affinity choline uptake (HACU)[7]. It has become clear, however, that AChE is also present in a variety of non-cholinergic neurones[8-10], which limits its usefulness as a marker. Localization of HACU is technically difficult and is also not entirely specific because non-cholinergic cells, such as rabbit photoreceptors, display HACU[11]. So far, ChAT has been the only reliable marker for cholinergic neurones, although controversy about the specificity of antibodies to ChAT has plagued the field for a long time[12]. Now that pure ChAT and monoclonal antibodies against the enzyme have become available[4-6], ChAT-immunohistochemistry is very useful for identification of cholinergic neurones.

Photomicrograph of ChAT immunoreactivity in 30 – 40 μm diameter multipolar neurones in the basal forebrain of the rat. In this area, neurones of similar morphology have been labelled by Geffard *et al.*[1] using their antibodies to ACh.

In addition to confirming results obtained with antibodies to ChAT, the immunohistochemical localization of ACh offers other advantages. First, due to the limited cross-reactivity of ChAT-antibodies from different species, cholinergic neurones could be identified by this method only in vertebrates, whereas antibodies to ACh should have broader cross-reactivity. Second, the method for the preparation of antibodies to ACh described by Geffard *et al.* is simple enough for others to follow easily, whereas the preparation of antibodies to ChAT requires cumbersome purification of the enzyme.

One potential problem of the method lies in the way ACh has to be modified to allow its fixation. This step involves the substitution of the acetyl group of ACh with another group that is subsequently fixed in the tissue. It seems possible that this method will not only identify cholinergic neurones but also structures containing other choline metabolites. The rabbit photoreceptor, because of its high choline metabolism, should be a good model for testing this reservation. On the other hand, it is encouraging that the staining pattern obtained by Geffard *et al.* closely resembles that seen with ChAT-immunochemistry (see figure). This novel method is a more than welcome addition to the field, and one that is likely to add considerably to our understanding of the organization of cholinergic systems. □

1. Geffard, M., McRaie-Degeurce, A. & Souan, M.L. *Science* **229**, 77 (1985).
2. Koelle, G.B. & Friedenwald, J.S. *Proc. Soc. exp. Biol. Med.* **70**, 617 (1949).
3. Shute, C.C.D. & Lewis, P.R. *Nature* **199**, 1160 (1963).
4. Eckenstein, F. & Thoenen, H. *EMBO J.* **1**, 363 (1982).
5. Houser, C.R., Crawford, G.D., Barber, R.P., Salvaterra, P.M. & Vaughn, J.E. *Brain Res.* **266**, 97 (1983).
6. Levey, A.I., Armstrong, D.M., Atweh, S.F., Terry, R.D. & Wainer, B.H. *J. Neurosci.* **3**, 1 (1983).
7. Baughman, R.W. & Bader, C.R. *Brain Res.* **138**, 469 (1977).
8. Butcher, L.L., Talbot, K. & Bilezikijan, L. *J. Neural Transm.* **37**, 127 (1975).
9. Eckenstein, F. & Sofroniew, M.V. *J. Neurosci.* **3**, 2286 (1983).
10. Levey, A.I., Wainer, B.H., Mufson, E.J. & Mesulam, M.M. *Neurosciences* **9**, 9 (1983).
11. Masland, R.H. & Mills, J.W. *J. cell Biol.* **83**, 159 (1979).
12. Rossier, J. *Int. Rev. Neurobiol.* **20**, 284 (1977).

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