Mesectodermal capabilities of the trunk neural crest of birds

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SUMMARY

Orthotopic transplantation experiments have shown that in birds, under normal conditions, mesectodermal capabilities seem restricted to the cephalic neural crest down to the level of the 5th somite.

In the present study the mesectodermal capabilities of trunk and lumbar neural crest were investigated at early stages of development by heterotopic, heterospecific transplantation of the neural primordium. The quail-chick nuclear marker system was used to identify the grafted cells.

Mesectodermal cells did not arise from the trunk neural crest when this was implanted orthotopically, even though the neural primordium was taken early in development at the level of unsegmented plate mesoderm just anterior to Hensen’s node.

Mesectodermal derivatives (connective tissues, dermis and muscle but no cartilage or bone) developed from the same trunk neural crest fragments when they were heterotopically grafted at the cephalic level and mixed with host cephalic neural crest cells. These host cephalic neural crest cells emigrated from the contralateral neural primordium when the graft was unilateral or from the fringe area of the operation in cases of bilateral transplantations.

As a control, unsegmented paraxial mesoderm was inserted alongside the cephalic neural tube; its cells did not migrate ventrally in the neural crest-derived area and they differentiated in the dorsal region of the host.

These results indicate that mesectodermal capabilities, though reduced, exist in the trunk neural crest at early stages of development but the differentiation of these mesectodermal derivatives is largely dependent upon environmental influences which may be found in early cephalic levels.

INTRODUCTION

The neural crest is a transitory embryonic structure which plays an important role in the development of many organs owing to its wide range of derivatives (reviewed by Weston, 1970; Le Douarin, 1976). These include neurons (sensory, sympathetic and parasympathetic) and supporting cells of the peripheral nervous system, pigment cells, glandular cells (carotid body, adrenal and

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calcitonin containing), and mesoderm derivatives (cartilages and bones, dermis, connective tissues and muscles) (Le Lièvre & Le Douarin, 1975; Noden, 1978).

One of the problems in considering neural crest development concerns how and when its various derivatives become determined; whether early, before the closure of the neural tube, during the migration of neural crest cells, or after their final localization at the site of their differentiation.

When cephalic neural crests were grafted at the trunk level, they gave rise to some cartilage and connective tissues, though trunk neural crest under normal conditions does not (Le Douarin & Teillet, 1974). In contrast the bilateral graft of the trunk neural primordium at the head level results in severe malformations similar to those observed after excision of the cephalic neural crest, consequential to the absence of facial or/and branchial mesectoderm (Le Douarin, Teillet & Le Lièvre, 1977).

The restriction of mesectodermal precursors to the cephalic region implies a segregation of the corresponding cell line from the neural crest population before the beginning of the migration process. If such is the case the mesenchymal stem cells are determined at an early stage and would thereafter be distinct from the non-mesenchymal precursors.

In lower vertebrates some mesectodermal derivatives arise from the trunk neural crest. In amphibians trunk neural crest cells give rise to the dorsal fin mesenchyme though they never produce cartilage or bone even when transplanted to the cephalic region (Chibon, 1966).

Therefore we have examined whether, in birds, mesectodermal capabilities could be found in the trunk neural crest in experimental conditions at an early stage of development.

The posterior neural primordium was taken early in its development and transplanted heterotopically to the cephalic level. Most grafts were performed only on one side. The quail/chick marker system (Le Douarin, 1969, 1973) was used to identify and follow the grafted cells during their differentiation. Orthotopic early grafts at the thoracolumbar level or grafts of unsegmented mesoderm at the head level served as controls. The results indicate that mesectodermal capabilities exist in the trunk avian neural crest but that the expression of such capabilities depends rather on the early cephalic environment of the grafted neural crest than on the stage of the donor on which the neural tissue was excised.

MATERIALS AND METHODS

Embryos of White Leghorn chick (Gallus gallus domesticus) and Japanese quail (Coturnix coturnix japonica) were used throughout this investigation.

(I) Experimental procedure

Four sets of experiments were performed as indicated in Figures 1 and 2.
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(1) Unilateral heterotopic transplantation of quail trunk neural primordium into the chick at the cephalic level (Fig. 1a)

(a) Preparation of the host. A fragment of anterior and/or middle rhombencephalic primordium (down to the level of the first somite) was mechanically excised on one side from a 6 to 10-somite chick embryo (stages 9 and 10 of Hamburger & Hamilton, 1951) using sharpened steel needles.

(b) Preparation of the graft. Donor quail embryos from the 15- to 25-somite stage were used (stages 12 to 15 according to Hamburger & Hamilton, 1951). Their posterior unsegmented region, just anterior to the sinus rhomboidalis, was excised. This fragment contained the posterior thoracic and lumbar regions of the neural primordium (between the levels of the 20th and 30th somites). It was incubated for 10–15 minutes at 4 °C in 0.5% trypsin (Difco) in calcium- and magnesium-free Tyrode solution. In the majority of cases the developmental stage of the graft was either $\alpha$ or $\beta$ as defined in Fig. 2D.

(c) Grafting. The quail neural primordium was then placed in the chick host in the groove left by previous excision of the rhombencephalic neural tissue. Anterior–posterior and dorsoventral orientations were maintained.

(2) Bilateral orthotopic transplantation of quail neural primordium into chick at the thoracolumbar level (Fig. 1b)

The same procedure as before was used but in these experiments stages of quail donor and chick host were identical. The excision of chick neural primordium was done bilaterally at the same level as that of the quail graft, corresponding to the future posterior trunk and/or anterior lumbar region.

(3) Transplantation of mesoderm (Fig. 1c)

We isolated the paraxial mesoderm in the unsegmented region just lateral to the excised quail neural primordium used in the previous experiments. The graft was inserted in a cut made lateral to the chick rhombencephalic neural tube. Donor quail embryos were from stages 16–23 somites, host chick embryos were from stages 6–10 somites.

(4) Bilateral heterotopic transplantation of quail trunk neural primordium into the cephalic regions of the chick (Fig. 2)

Quail donors were from stages 11 to 29 somites (stages 11 to 17 of Hamburger and Hamilton) and the graft consisted of the whole neural primordium (neural tube and crest) at the level of the 1–6 last somites and, sometimes, of the unsegmented mesoderm. It was isolated after enzymic preparation as previously described. Considering developmental stages of the neural primordium as represented in Figure 2D, the grafts were mostly isolated at stage $\beta$, some being also partly at stage $\gamma$ (5) or $\alpha$ (3). Two grafts were at the early stage $\alpha$. 
Fig. 1. Experimental procedure. (A) A piece of the quail donor embryo, between the last somite and the sinus rhomboidalis (Si) was excised and placed in a solution of trypsin. (B) Ten minutes later, the segment to be grafted (\\) was dissected. It corresponded to the level of 5th to 10th somite after the last somite formed. This fragment was inserted in the chick host embryo into the groove left by the excision of host neural primordium. (a) Unilateral heterotopic transplantation of neural tissue to the rhombencephalic level. (b) Orthotopic bilateral transplantation of neural tissue. Donor and host embryos were at the same stage of development. (c) Heterotopic transplantation of mesoderm. Unsegmented presomitic mesoderm (-----) was dissected on one side of the quail embryo. It was then inserted into a slit just lateral to the rhombencephalic neural tube. En, endoderm; Ec, ectoderm; m, unsegmented mesoderm; N, notochord; NT, neural tube; S, last somite; Si, sinus rhomboidalis.

In separate experiments the grafts were implanted at three different levels:
(a) at the mesencephalic level of 4- to 6-somite embryos (Fig. 2a).
(b) at the rhombencephalic level of 7- to 10-somite embryos (Fig. 2b).
(c) at the vagal level (1st to 7th somite) of 7- to 12-somite embryos (Fig. 2c)

(II) Fixation and histological preparation

Host embryos were sacrificed from 5 to 18 days of total incubation (stages 24–44 of Hamburger and Hamilton), in most cases at 7 days (stages 29–30). The trunk and head were fixed in Zenker's or Carnoy's fluid. Serial 7 \(\mu\)m-thick
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Fig. 2. Experimental procedure for heterotopic bilateral graft of quail trunk neural primordium to different cephalic levels of the chick. A segment of the quail donor embryo containing either segmented or unsegmented mesoderm was excised between the levels indicated on the diagram by arrows (L). (A) Illustration of one excision. (B) This segment of quail embryo was placed in a solution of trypsin. The neural primordium was then dissected out for grafting (\(\cdots\)). (C) The graft was implanted in the chick host in the groove (hatched area) left by an excision, (a) at the mesencephalic level, (b) at the rhombencephalic level, (c) at the vagal level. (D) The neural primordium of the quail was grafted at different stages of its evolution. The three major stages used are shown here (\(\alpha\)) neural folds are formed, (\(\beta\)) neural tube is closed, (\(\gamma\)) neural crests are starting to migrate.
sections were cut and stained according to the Feulgen and Rossenbeck procedure (1924). This allows quail and chick cells to be distinguished (Le Douarin, 1969).

RESULTS

(I) Unilateral heterotopic transplantation of trunk neural primordium
to the cephalic level

Thirty-eight operated embryos were studied. Respectively 7, 3, 15 and 13 donor embryos were at stages 12, 13, 14 and 15 of Hamburger and Hamilton. Stages of the donor embryos whose trunk neural crest gave rise to mesectoderm in chick hosts ranged from 15 to 25 somites. Stages of the chick hosts at the time of the graft varied between 6 and 10 somites. There was no evidence that the results were affected by the stages of donor or host embryos in the present experiments. After these unilateral heterotopic grafts, the face and neck of these embryos looked normal. Some dorsal malformations were observed at the graft level and these were probably due to the replacement of a half rhombencephalon by spinal cord tissue, which is differently shaped. Histological observation of 5- and 6-day operated embryos revealed that quail cells could take part in the formation of the second branchial arch. Most of the branchial mesenchyme, however, consisted of host cells, which suggests that regulative phenomena from contralateral crest material contributed to the formation of the branchial region. This phenomenon has also been observed, though less extensively, after unilateral grafts at the cephalic level (Noden, 1973).

From 6-5 days on, the differentiation of mesectodermal cells proceeded. In 12 out of 35 cases quail mesectodermal cells were observed in the mesenchyme corresponding to the second branchial arch material (Figs. 3 and 4). They were mainly found posterior and ventral to the first branchial pouch or eustachian tube where connective tissue is known to be of neural crest origin (Le Lièvre & Le Douarin, 1975). Masses of quail connective cells were seen there, and few, if any, chick host cells intermingled with them. Quail cells also differentiated into dermis in the otic region (Fig. 5) and took part, with host cells, in the constitution of the musculoconnective wall of the carotid artery (Fig. 7). As observed in orthotopic transplantation of crest at the head level (Le Lièvre & Le Douarin, 1975), the crest cells never formed endothelial cells, which originate

Figs. 3 and 4. Differentiation of mesectoderm from the heterotopically transplanted quail thoracolumbar neural primordium. The graft was made at the level of the rhombencephalon. The chick host was fixed at stage 28–29 of Hamburger and Hamilton. Feulgen and Rossenbeck (1924) staining.

Fig. 3. Localization of the quail mesectoderm, surrounded by dotted lines. J, Jugular vein; Ph, pharynx. × 150.

Fig. 4. Quail cells constitute part of the mesenchyme corresponding to the second branchial arch region while the pharyngeal epithelium (ph) consists of chick cells. × 600.
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from mesoderm. In these experiments the neural crest from trunk levels did not differentiate into hyoid or otic cartilages.

The grafted neural tissue did not develop the normal morphology of the rhombencephalic neural tube. Cells from the neural crest of the graft, however, also took part in the formation of the cranial peripheral nervous system of the host and by comparing the ganglia which were formed on the operated side with the contralateral neural anatomy, we were able to identify the various cranial sensory and parasympathetic ganglia which contained quail cells. Quail cells were seen in the trigeminal sensory ganglion and even in the ciliary ganglion when the graft was made at the anterior rhombencephalic level (Fig. 6). They were found in the root and trunk ganglia of the seventh and ninth cranial nerves as well as in the acoustic ganglia when the graft was performed at the middle rhombencephalic level (between the first rhombencephalic constriction and the first somite). They also differentiated as Schwann cells along the emerging cranial nerves. In some cases, quail cells were observed in the contralateral cranial ganglia, which confirmed the contralateral migration of the neural crest cells in the cephalic region. Small ectopic ganglia which resembled sensory ganglia were present close to the grafted spinal cord in most cases.

(II) Orthotopic transplantations of the neural primordium at the thoracolumbar level

In the 16 operated embryos the quail neural tube was found between levels corresponding approximately to somites 25–32. Usually 4–5 dorsal root ganglia located between the 5th thoracic and the 5th lumbar ganglia were derived from grafted neural crest. Grafted cells also gave rise to the corresponding sympathetic ganglia, to adrenal, aortic and celiac plexuses and were found as far caudal as the pelvic plexus. Quail cells differentiated within the Remak ganglion and occasionally in the lower region of the adrenal medulla. Thoracolumbar crest cells were never found in enteric ganglia nor in mesenchyme of the trunk and abdomen.

Figs. 5–7. Same operations as in Figs. 3 and 4. Feulgen and Rossenbeck staining (the host embryo was fixed at stage 29 of Hamburger and Hamilton).

Fig. 5. Mesectodermal quail cells from the graft are present in the skin region of the pre-otic area, corresponding to the 2nd branchial arch material. The epidermal layer (E) is made of chick host cells. ×1700.

Fig. 6. Numerous quail cells from the graft take part in the formation of the trigeminal ganglion. ×420.

Fig. 7. The host embryo was fixed after 13 days of incubation. Quail cells (→) differentiated in the wall of the carotid artery except for the endothelium (⇒) which is entirely derived from the host mesoderm. L. Lumen of the vessel. ×1790.
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Fig. 10. The respective localizations of neural crest-derived (mesectoderm) and mesoderm (mesenchymal areas) are indicated on this drawing of a transverse section through the head and neck of a 7-day chick embryo. C, carotid artery; J, jugular vein; N, notochord; NT, spinal cord; Q, quadrate; T, tongue; IX, glossopharyngeal nerve.

(III) Heterotopic transplantation of unsegmented mesoderm

The grafted mesoderm developed locally in the dorsal region of the host embryo. It contributed to the formation of dermis, cartilage in the lower skull and vertebrae (Fig. 8), connective tissue and muscles. It also produced endothelial cells as well as the rest of the wall for the blood vessels of the region (Fig. 9).

Cells from the grafted mesoderm were never found in the pharyngeal and branchial regions (Fig. 10), they never migrated to these ventral regions.

Figs. 8 and 9. Differentiation of the quail thoracolumbar unsegmented mesoderm when transplanted into the rhombencephalic region of a chick embryo. Feulgen and Rossenbeck staining.

Fig. 8. The host was fixed at stage 29–30 of Hamburger and Hamilton. Quail chondrocytes have differentiated in the occipital cartilages. × 610.

Fig. 9. The host was fixed at stage 29–30 of Hamburger and Hamilton. Quail cells are present in the dorsal mesenchyme of the chick. They also give rise to some endothelial cells (→) of blood vessels. L, Lumen of the vessel. × 1310.
Table 1. Bilateral heterotopic transplantation of trunk neural primordium to different cephalic level, localization of trunk mesectodermal cells

<table>
<thead>
<tr>
<th>Level of the graft</th>
<th>Frontocular and palatal region</th>
<th>Tongue, articular part of lower jaw</th>
<th>Upper otic region</th>
<th>Lower carotid and thymus, UB regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesencephalon</td>
<td>+(10)</td>
<td>+(10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhombencephalon</td>
<td></td>
<td></td>
<td></td>
<td>+(0)</td>
</tr>
<tr>
<td>Vagal level</td>
<td></td>
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<td>+(0)</td>
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Normal origin of mesectoderm in these localizations

Prosencephalo-mesencephalic neural crest

Mesencephalo-rhombencephalic neural crest

Rhombencephalo-vagal neural crest

(IV) Bilateral heterotropic transplantation of trunk neural primordium to the cephalic level

Twenty-eight grafts were made at various cephalic levels (Fig. 2, Table 1). Nine donors were at stage 11 and 12 of Hamburger and Hamilton, 16 at stage 13–14, and 7 at stage 15–17. Most operated embryos, particularly when the graft was done at the mesencephalic level, presented severe malformations of the face and ventral part of the neck, indicating large deficiencies of mesectoderm.

Cells from the grafted trunk neural crest took part in the formation of cranial sensory and parasympathetic ganglia. They also constituted ectopic ganglionic masses.

A few mesectodermal quail cells were also identified either as islets in the chick host mesenchyme or more dispersed but constituting at least 10% of the local population. The localization of these mesectodermal quail cells varied greatly according to the level of the graft (Fig. 11, Table 1): they were found in the frontal ocular and parietal regions (6/10 cases), in the tongue and in the lower jaw articular region (3/10 cases) when the graft was done at the mesencephalic level. They developed in the dermis and mesenchyme at the level of the upper part of the carotid and eustachian tube (7/11 cases), or around the lower part of the pharynx and its derivatives corresponding to the 4th and 5th branchial arch mesenchyme (1/11 cases), when the graft was done at the rhombencephalic level. If the trunk neural tube and crest replaced the vagal primordium, quail mesectoderm was located around the lower part of the carotid and thymus (8/12 cases) in a region corresponding to the 3rd branchial arch.
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Fig. 11. These drawings indicate on 7 day chick embryos: (A) The respective locations of prosencephalic (::__::), mesencephalic (:::::), rhombencephalic (|||) and vagal (______) neural crest. (B) Where quail mesectodermal cells localize after bilateral heterotopic transplantations of quail trunk neural crest to various cephalic levels of the chick (cf. Fig. 2, Table 1). In our experimental conditions trunk mesectodermal cells are found in three main regions (a, b, c) where the mesenchyme normally originate in segments of the neural primordium at the (___) fringe areas of the grafts: limit of zone of prosencephalic and mesencephalic (a), mesencephalic and rhombencephalic (b) or lower part of rhombencephalic and vagal (c) neural primordia.

DISCUSSION—CONCLUSIONS

Under the conditions of unilateral heterotopic grafts, cells from the thoracolumbar neural crest may give rise to mesectodermal derivatives. When grafted at the rhombencephalic level these cells can follow the normal migration pathways of rhombencephalic neural crest cells and like them (cf. Le Lièvre & Le Douarin, 1975; Noden, 1975), they can participate in the formation of the second branchial arch and subsequently differentiate into connective and muscular tissues of the corresponding cervical region.

However this participation is generally limited in amount, mesectodermal cells with ectopic origin only constituting small clusters of cells. They are far less numerous than the mesectodermal cells which normally derive from the rhombencephalic primordium at the level of the graft. Regulation phenomena from the contralateral rhombencephalic neural crest certainly account for the absence of malformation in the face and neck of operated embryos. Such malformations resulting from the reduction of mesectodermal derivatives at the level of the operation were observed after complete excision of the rhombencephalic and/or
mesencephalic primordia (Hammond & Yntema, 1964; Le Lièvre, 1974). They were also obvious after bilateral heterotopic graft experiments as described in this paper and by Le Douarin et al. (1977). In these experiments mesectodermal cells which differentiated from the trunk neural crest were too few to allow normal morphogenesis of the head and neck.

In view of the possibility of a chance contamination of the graft by unsegmented paraxial mesoderm we grafted this mesoderm alone and compared the results of these operations with those of neural primordium grafting experiments. Cells from the grafted mesoderm did not migrate ventrally in the branchial regions. Their derivatives (cartilage, connective tissues, muscles and vascular endothelia) and the mesectodermal ones ended up in distinct locations (Fig. 10). These results are in agreement with those of grafting experiments of somitic cells between neural tube and somites (Erickson, Tosney & Weston, 1980).

The results from these experiments demonstrate that although mesoderm and neural crest of the same level might have similar differentiation capabilities they differ very early in their migration abilities. In addition these results indicate that under our experimental conditions any contamination of the graft by mesodermal cells would have been easily detected.

Furthermore trunk mesectodermal cells in birds differ from their cephalic counterpart by their conspicuous inability to give rise to skeletal derivatives (cartilages and bones). Similarly, in the normal development of amphibians, the trunk neural crest participates in the formation of the dorsal fin but does not form chondrocytes. In heterotopic transplants amphibian trunk neural crest cells formed neither cartilage nor bone (Raven, 1936; Chibon, 1966). Two mesectodermal cell lines could thus separate early in the neural crest, one giving rise to skeleton (chondrocytes and bones), the second to other mesenchymal tissues (connective, muscular cells).

Though the existence of mesectodermal capabilities in the thoracolumbar neural crest is proved by our heterotopic graft experiments, they cannot be expressed in normal developmental conditions; the results of orthotopic grafts of thoracolumbar neural primordium, though they were carried out much earlier in neural development, were similar to those of Le Douarin & Teillet (1974). For similar reasons the posterior limit for the expression of mesectodermal capabilities in normal conditions was fixed at the 5th somite level (Le Lièvre & Le Douarin, 1975). Mesectodermal cells did not differentiate from the thoracolumbar neural crest when it was left in its normal environment.

Mesectodermal cells have been obtained in both series of neural tissue transplantation from trunk neural primordium at any stage of development from neural folds to closed neural tube and the beginning of neural crest cells migration (stages α, β, γ).

Thus, within the limits of our experiments the expression of mesectodermal capabilities by the trunk neural crest cells does not depend on their develop-
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mental state at the moment of the graft but rather on the environmental conditions in which they were allowed to develop.

The influences of environmental conditions on the differentiation of neural derivatives of the neural crest have been extensively studied and have been shown to have a decisive effect in the expression of the adrenergic or cholinergic phenotype in neuroblast differentiation (Le Douarin & Teillet, 1974; Le Douarin, Renaud, Teillet & Le Douarin, 1975; Le Douarin, Teillet, Ziller & Smith, 1978; Smith, Coehard & Le Douarin, 1977; Teillet, Coehard & Le Douarin, 1978; Patterson, 1978; Johnson et al. 1980; Le Lievre, Schweizer, Ziller & Le Douarin, 1980). Such influences might also interfere with mesectodermal development. Thus the trunk region environment (provided by neural tube and notochord, somites and ectoderm) in contrast to the cephalic one might be inappropriate for the migration and early differentiation of the neural crest cells which have mesectodermal capabilities.

The composition of the intercellular environment in which neural crest cells migrate is being investigated by various authors. It has been shown that migration pathways of neural crest cells, which express mesectodermal capabilities (cephalic ones), are characterized by the presence of glycosaminoglycans, particularly hyaluronic acid (Pratt, Larsen & Johnston, 1975), and fibronectin (Newgreen & Thiery, 1980), both being also secreted by cephalic neural crest cells in culture (Greenberg & Pratt, 1977; Newgreen & Thiery, 1980). At the trunk level the proportion of sulphated GAG versus hyaluronic acid differs and furthermore varies in the course of development (Pintar, 1978; Derby, 1978); though fibronectin is present in the trunk neural crest migration pathways, trunk neural crest cells themselves secrete little if any of it in culture (Newgreen & Thiery, 1980).

In the unilateral heterotopic graft conditions of our experiments, the few thoracolumbar crest cells with mesectodermal capabilities were mixed with the rhombencephalic host crest cells from the other side of the embryo and thus might have found an adequate environment for their migration and early differentiation. These conditions are absent in the normal development of the trunk or in bilateral heterotopic graft conditions for cells originating in the central part of the graft. But the neural crest cells emigrating from both ends of the graft are mixed with host cephalic neural crest cells from the neighbouring levels of the host neural primordium. They actually differentiated into mesectodermal derivatives in some areas of the face and branchial regions known to originate in a region of the neural crest corresponding to the fringe area of the graft.

Conversely, mesectodermal derivatives (connective tissues, cartilage) were obtained in the trunk region, notably in the intermediate plate mesoderm when cephalic neural primordia were heterotopically grafted in the thoracic region (Le Douarin & Teillet, 1974). This might depend upon a sufficient modification of the host trunk environment in the operated region by the grafted cephalic
neural primordium, neural tube and crest, itself. The early cephalic structures, notably the cephalic ectomesenchyme, apparently provide appropriate conditions for the development of mesectodermal derivatives.

We face two alternatives concerning the state of neural crest determination before cell migration starts: either it consists of a mosaic of different predetermined cell types, or pluripotential crest cells are present throughout the neural axis. In the first hypothesis one could assume that the number of cells which are predetermined as mesectodermal is much smaller at the trunk than at the head level, resulting in the development of reduced amounts of mesectodermal derivatives from the trunk neural primordium. If there are, however, predetermined mesectodermal cells in the trunk neural crest, in normal conditions, do they migrate and disappear or remain undifferentiated? In the second hypothesis, if crest cells are still pluripotent, their final differentiation would depend upon influences from their environment and they might produce one or the other type of trunk crest derivatives (pigment cells or peripheral nervous tissue).

RÉSUMÉ

Dans les conditions normales, chez les oiseaux, les expériences de greffes orthotopiques d'ébauche neurale, précédemment réalisées, n'ont pu mettre en évidence de capacités mésectodermiques dans les crêtes neurales en dehors des régions céphaliques, antérieures au niveau des 5° somites.

Le présent travail avait pour but de poursuivre la recherche de capacités mésectodermiques des cellules des crêtes neurales troncales et lombaires aux stades précoces du développement. Des greffes hétérotopiques, hétérospecifiques, d'ébauches neurales ont été réalisées. Le marquage caille-poulet a été utilisé pour retrouver les cellules des greffons.

Les crêtes neurales troncales et lombaires ne produisent pas de mésectoderme lorsqu'elles sont placées en greffes orthotopiques, bien que l'ébauche neurale ait été prélevée très tôt au niveau encore insegmenté du méso derme somitique, juste en avant du noeud de Hensen.

Par contre des dérivés mésectodermiques (tissus conjonctifs, derme et muscle) à l'exclusion des dérivés squelettiques (os et cartilage) se sont différenciés à partir du greffon lorsque les fragments d'ébauche neurale troncale ont été placés en position hétérotopique au niveau céphalique et que les cellules des crêtes neurales greffées ont pu se mélangier aux cellules des crêtes neurales céphaliques de l'hôte. De telles conditions sont réalisées aux régions limitrophes de l'opération dans les cas de greffes bilatérales et au niveau de la greffe même lorsque celle-ci est unilatérale et que des migrations contralatérales des crêtes neurales céphaliques de l'hôte peuvent avoir lieu.

A titre de contrôle, des fragments de mésoderme somitique insegmenté ont été insérés le long du tube neural. Ces cellules mésodermiques ne migrent pas ventralement dans les régions normalement colonisées par les cellules issues des crêtes neurales, elles se différencient dans la région dorsale de l'hôte.

Les résultats obtenus indiquent que des capacités mésectodermiques, bien que réduites existent aux niveaux postérieurs (troncal et lombaire) des crêtes neurales chez l'oiseau, mais que la différenciation de tels dérivés dépend largement de l'environnement offert aux cellules des crêtes neurales troncales au début de leur développement. Des conditions favorables à la mise en place de dérivés mésectodermiques existent précocement dans les régions occupées par les cellules des crêtes neurales céphaliques.

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