Companions at a Distance: 
Technoscience, Blood, and the Horseshoe Crab

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Abstract
In this paper we present a particular history of *Limulus polyphemus*, the horseshoe crab, as a means of expanding on Haraway’s notion of companion species. Drawing on accounts of the horseshoe crab’s role, on the one hand, in work of the Serological Museum at Rutgers University that spanned the 1940s to the 1970s, and, on the other, in the development of the limulus amebocyte lysate test, we trace some of the complexities of human-limulus relations. These relations encompassed not only the horseshoe crab’s objectification (as a source of serum), but also the natural historical, the mythical, and the symbolic (in relation to its blue blood or its supposed status as a “living fossil”). We suggest that the horseshoe crab, and similarly alien or abjected species, can be valued as companion species if this concept is expanded beyond parameters such as intimacy, surprise, and “becoming-with” to include distanciation, wonder, and “becoming-because-of.”

Keywords
companion species, horseshoe crab, human-nonhuman animal relations, limulus test

Introduction
It goes without saying that relations between human and nonhuman animals are complex and multifarious. In no small measure, this reflects the sheer diversity of nonhuman animals and their qualities, but it also reflects the diversity of which nonhuman animals as subjects and objects, bodies and symbols, have been put. How do we approach such variety, which encompasses companion animals, charismatic megafauna, commodified species, and abjected others? In what ways might we think such relations that are manifested in and across domestic, industrial, touristic, consumer, ecological, or technoscientific settings? How do we navigate through the cacophony of voices that represent nonhuman animals in terms of their rights, welfare, or
value, or that argue for their necessary use in meeting human biomedical, pharmaceutical, and consumer needs?

This paper addresses such questions by trying to rethink human-nonhuman animal relations in terms of their complexity. The analysis will highlight the ambivalence at the heart of human-nonhuman animal relations, an ambivalence that straddles the divide between self and other, subject and object, and naturalistic and analytic. In order to do this, we attend to a particularly unpromising and—for some at least—unprepossessing species. Although the American horseshoe crab, *Limulus polyphemus*, is one of the best-researched marine arthropods (Garland, 2004, p. 1113), not least because of its importance to the pharmaceutical industry (see below), it has thus far been largely neglected in the social sciences. Yet, as we shall argue, this species combines elements of the “other,” the exotic, the ancient, the ecological, as well as the technoscientific and the commodified—a combination ripe for social analysis.

It strikes us that Haraway’s concept of “companion species” is a useful resource for thinking about this diversity, ambiguity, and complexity: it is a tool for allowing people to rethink (and feel) about how they understand and value nonhuman animals. Insofar as the horseshoe crab is a relatively obscure species that is nevertheless deeply implicated in the activities of commercial and academic biomedicine and technoscience, it poses a challenge: how might we think about *Limulus polyphemus* as a companion species? What work must we do on this concept so that it can further illuminate our thinking (and feeling) about more “distanciated” nonhuman animals—that is, those species that have hitherto remained resolutely unfamiliar or exotic for the vast majority of people?

In what follows, we present a history of *Limulus polyphemus*. This very particular history takes us back to the Serological Museum at Rutgers University between the 1940s and the 1970s, and to the development and entrenchment of the limulus amebocyte lysate test (henceforth, LAL). Insofar as “[c]ompanion species rest on contingent foundations” (Haraway, 2003, p. 9), we use this concept to retrace the contingency of present-day valuations of the horseshoe crab through a contrast to prior valuations when the horseshoe crab first emerged as “useful.” As such, our paper is narrated in relation to some of the key themes associated with the notion of “companion species”—themes that partly derive from the etymology of companions as those who break bread together at table. For each theme, we attempt to think its applicability, and adaptation, to the horseshoe crab.

We begin with a brief exposition of the concept of companion species to set up the thematized analysis that follows. We then present a background history for the horseshoe crab, focusing especially on its role in the Serological Museum and the development of LAL. Subsequently, we explore this history in more
detail through themes derived from the notion of companion species. Thus, we consider how the horseshoe crab might possibly be a “companion”—that is, share bread with us at table. We pose, therefore, three questions: Who can sit around the table? What is on the table? What are the qualities of the table? Each of these questions allows us to explore different dimensions of the possible and contingent companionability of *Homo sapiens* and *Limulus polyphemus*. In the process we attempt to gain a better grasp of the diversity and the complexity of human-nonhuman animal relations. In our conclusion we elaborate a notion of “companion species at a distance,” which might enrich the ways in which we value the horseshoe crab, but also various species that are otherwise obscure, invisible, or “other.”

**Donna Haraway’s Companion Species**

Haraway’s general project has always concerned a sensibility for the complex and the mixed. Not for her the simplicities of object/subject or material/cultural divides; rather, the aim is to examine in detail their ongoing interdigitations in the heterogeneity and processuality that characterize the worlds of technonatures or naturecultures. On this score, she is part of a lineage (among others in feminist theory and politics, science fiction, and cultural studies) that in the 20th and 21st centuries includes Whitehead, Deleuze and Guattari, Serres, Latour, and Stengers, among many others. In relation to nonhuman animals, an earlier form of this focus upon process, heterogeneity, and complexity can be found in Haraway’s review essay of Barbara Noske’s (1989) germinal *Humans and Other Animals*. While Noske (1989, p. viii) strongly argues against nonhuman animals’ object status, Haraway (1992) writes:

> The last thing “they” (nonhuman animals) need is human subject status, in whatever cultural-historical form….We need other terms of conversations with animals, a much less respectable undertaking. The point is not new representations, but new practices, other forms of life rejoining humans and not-humans. (pp. 86-7)

Out of this emerges, Haraway hopes, a new form of human being:

> Once the world of subjects and objects is put into question, that paradox concerns the congeries, or curious confederacy, that is the self, as well as selves’ relations with others. A promising form of life, conversation defies the autonomization of the self, as well as the objectification of the other. (p. 90)

Haraway’s more recent work (2008) can be thought of as a fleshing out of this conversation through the figure of companion species. Typically, this concept
is hugely complex and, from more traditional perspectives, contradictory. That is, it is a hybrid: we have both the intersubjective or naturalistic animal connoted in “companion,” and the objective or analytic animal connoted in “species” (see Lynch, 1988). On this score it resembles, perhaps, Haraway’s most famous figure, the cyborg (Prins, 1995; Haraway, 1991). Like the cyborg, the companion species brings together “the human and non-human, the organic and technological, carbon and silicon, freedom and structure, history and myth, the rich and the poor, the state and the subject, diversity and depletion, modernity and postmodernity, and nature and culture in unexpected ways” (Haraway, 2003, p. 4).

For Haraway (2008, p. 16), the concept of the companion species serves as a “pointer to an ongoing ‘becoming with’”—companion species emerge together through their “intra-actions” (Barad, 2007). Companion species are thus relational, and they cohabit with us, even to the point of being at the same table, breaking bread together. This relationality is not simple or easy or convenient but rather shot through with potential and actual tensions and misunderstandings, moments of identity and a backdrop of otherness, relations of power that extend all the way through the history of human-nonhuman animal relations.

But let us briefly consider the introduction of the horseshoe crab at table in terms of Michel Serres’s (1982) notion of the parasite. For Serres, the notion of the parasite, in addition to its usual biological meaning, also means (in French) noise that disrupts communication. Serres explores the productivity of this parasite/noise through information theory—how its interventions in the process of communication yield increased levels of complexity. In his initial introduction to the parasite, Serres retells La Fontaine’s parable of city and country rats “at table,” where the former invites the latter to eat, even though the only thing the latter can offer in return is stories. Put very simply, the country rat parasitises on the city rat’s meal, but in doing so it introduces stories that make the setting more complex. Drawing on this parable, we can ask: how can we tell stories about the horseshoe crab (with its alien body, with its otherness as a “living fossil”) so that we can disrupt its current generally abjected status, and it can join us as a companion at table? In the process, we use this storying to complexify the notion of companion species. What are the stories that we can tell such that limulus’s bizarre appearance, its seasonal gatherings on the Atlantic beaches of the United States, its biomedical uses, enable a more complex table-setting and companionship?

In the next sections, we present a brief introduction to the horseshoe crab. This is then elaborated; our historical narratives are structured in relation to the figure of companion species. We will take seriously the etymology of “companion” and ask: Who can sit at this table? What is on it? What does it mean to sit at table together?
The History of the Horseshoe Crab and its Blue Blood

*Limulus polyphemus* (see Fig. 1), with its uncanny blue blood, continues to be simultaneously a mythical creature and an asset to biomedical enterprise. As one scientist put it: “The lineage of this marine chelicerate arthropod is ancient, with fossils of close relatives dating back 450 million years” (Garland, 2004, p. 1113). It is described as a “living fossil” in both scientific texts (e.g., Iwanaga & Kawabata, 1998, p. 973) and in popular parlance (witness, for example, Wikipedia’s entry on horseshoe crab [Wikipedia], a US Fish and Wildlife Service fact sheet on the horseshoe crab [US Fish and Wildlife Service], or a Cape Cod vacation guide website [Capecodtravel.com]). With these connotations, it is profoundly other, a species from a distant past. And yet its clotting agent (*limulus* amebocyte lysate) provides the basis for an important pharmaceutical test that is used in contemporary clinical and research settings, and it is thus also deeply proximal—intimate, even. It is an integral part of a biochemistry and biomedical matrix that includes the running of healthcare systems and the production of vaccines.

Figure 1. A typical cluster of horseshoe crabs (Source: *Serological Museum Bulletin* 37, 1967)
Comparatively little has been written on the history of the LAL test and Frederick B. Bang and Jack Levin’s discovery of the potential of the horseshoe crab in the 1960s. A notable exception is Sargent’s (2002) impassioned account of the exploitation of the limulus. While acknowledging this, we differ from Sargent by attempting to recover some of the complexities of the history of the limulus—not least its situated capacity to generate a range of more nuanced and troubling reactions in the scientists who in fact pioneered its exploitation.

Frederick B. Bang, a pathobiologist at the Johns Hopkins University Institute for Infectious Diseases, was forced to work on marine organisms when he spent summers at the Marine Biology Laboratory (at Woods Hole). Together with the young Jack Levin he started to conduct experiments and later wrote papers on the endotoxin-LAL interaction mechanisms, publishing a description of a semiquantitative LAL test method. The detection of endotoxins in pharmaceuticals was described by J. F. Cooper at the beginning of the 1970s. The LAL-test proved highly successful and widely replaced the rabbit pyrogen test, in which rabbits were injected with substances and their physiological reactions observed (Weary, 1996).

Bang and Levin were not the only ones who were experimenting with limulus blood. A range of actors from medical research and biotech companies as well as from immunology and serology had become interested in the substance (Shuster, Barlow, & Brockmann, 2003). As a result, there were increasing demands for limulus serum, and over time it became indispensable in the world of modern hospitals and medical research. Serum-sourcing companies such as the Charles River Laboratories specialized in, among other things, collecting limulus blood. “Limulus Amebocyte Lysate (LAL) is the most sensitive and specific assay available to screen injectable drugs, biologics, medical devices, and raw materials for the presence of endotoxin” (Charles River Laboratories, n.d. a). Endotoxins stem from gram-negative bacteria that are hugely widespread in the environment, being found in both organic (e.g., gastrointestinal tracts, food) and nonorganic media (e.g., water), and include such species as E. coli and salmonella (Todar’s Online Textbook of Bacteriology, 2010). A classical proof of the test’s effectiveness can be found in the production of vaccines. These are prone to contamination by endotoxins carried in water and present at various steps in their production process. LAL can detect the presence of endotoxins in a variety of pharmaceutical processes and clinical settings and thus facilitate their eradication. Note that this function of the horseshoe crab’s blood is meaningful in that it is essential for combating the spread of infections, without itself becoming visible.

Biomedical companies such as the Charles River Laboratories are providers for the substances needed in the LAL test. On their website, we find the fol-
lowing information: “Each year we bleed horseshoe crabs using highly con-
trolled and monitored procedures that help to ensure that the donor crabs
are returned to their natural environment unharmed” (Charles River Labora-
tories, n.d. b). This is clearly not an equal relation, most obviously evidenced
in mortality rates of around 10-15% after bleeding (Walls & Berkson, 2000;
Rudlow, 1983). Key here is that the horseshoe crab’s substance turns the
animal into an important economic resource. As the narrator of a documen-
tary about the collecting activities of these laboratories put it: “For the past
30 years, the biomedical industry has been mining the medical equivalent of
gold” (Argo, 2008).

This brief overview suggests that the relations between humans and nonhu-
man animals are indeed intricate. Modern medicine is saturated by biological
substances from nonhuman animals providing preventative, diagnostic, or
therapeutic tools. Yet, the relations are complex and mediated. In what fol-
lows, we elaborate on this overview by situating the horseshoe crab and its
precious blood in a wider technical, social, and historical context.

To and from the Museum: Sampling Blood and Proteins . . .

From 1948, one scientific institution—the Serological Museum at Rutgers
University, a systematics collection of nonhuman animal bloods—focused
some of its attention on the limulus serum, once its useful characteristics came
to be known. The founder of the museum, Alan Boyden, a zoologist special-
izing in animal systematics and taxonomy, stood at the forefront of serological
research at the Bureau of Biological Research, an early life science organization
at Rutgers University (Rutgers University, n.d.). In the late 1940s and into the
1950s, it was by no means common to sample blood; such an endeavor had to
be defended (Gisler, 2010). In the first, subsequently monthly, issue of the
Serological Museum Bulletin, Alan Boyden assured the reader that the muse-
um’s activities were “dedicated to the principle that the proteins of the blood
and of other tissues of the bodies of organisms may be as characteristic of them
in health and in disease as are any of their other constituents and are as worthy
of preservation and study as their skins and skeletons” (Boyden, 1948, p. 1).
Here we see how his fellow zoologists had first to be convinced that collecting
blood was an important scientific activity, even as the traditional zoological
expeditions that usually brought back bones, carcasses, furs of animals, etc.
grew on the decline (Kohler, 2006).

By the 1950s the members of the Serological Museum were very aware of
limulus blood’s properties as an agglutinating agent having observed and
tested “its potent agglutinating activity against human and other red blood corpuscles” (Boyden, 1967, p. 10). But chiefly members of the museum proved to be zealous collectors of this increasingly precious biological substance in the field. Driven originally by the interest in nonhuman animal systematics, with the potential that the limulus might contribute to technologies for testing antigen-antibody reactions and thus support the work of taxonomy, the museum shifted over time from sampling for its own collection toward collecting for others, for biomedicine. The collection of, and research into, this serum can be contextualized more broadly. It took place at a juncture in the history of modern biology that entailed a complex shift from phenotype toward genotype-based research, and a transition from molecular biological to gene technological perspectives (Rheinberger, 2008) in which the study of living beings was replaced by a kind of engineering, a manipulation of living beings.

If the limulus is now an integral part of a particular medico-industrial complex, however, the above introductory history hints at a more ambiguous status—an ambiguity that will later be used to rethink the notion of companion species. For the present, we can elaborate on this ambiguous status by looking at some of the practices and discourses of the Serological Museum in a little more detail.

As a key scientist at the Serological Museum, Mabel Boyden provides an insightful glimpse into the bioscientific world of the late 1960s and the process of “harvesting” blue blood (Gisler, 2009). In a lengthy article, Boyden (1967) recounts a trip to collect the serum of the horseshoe crab at Delaware Bay. In her account, she does not simply provide data on, for example, the numbers of samples brought home and stored in the museum’s collections or describe the steps undertaken by the museum’s lab to preserve the serum—the ongoing purification processes and the analytics that follow. Alongside these “scientific” accounts are naturalists’ narratives about getting ready for the crabs in the moonlight, endless walks over mudflats, and the fascination of the crabs’ emergence from the ocean. Put another way, the “analytic animal” (Lynch, 1988) that emerges during her story is folded into accounts of the crab as a “naturalistic” animal: elements of the “intersubjective,” which take in the horseshoe crab in its ecological, aesthetic, and practical context, mingle with the objective, as the limulus is translated into a repository of organs, tissues, and biochemical processes.

The apparent contrast between these versions of the nonhuman animal and the human-nonhuman animal relation gets complicated, though. In interviews with UK scientists and technicians involved with animal experimentation, Michael and Birke (1994a, 1994b), found that scientists shifted between
these registers quite happily, moving from their love of companion animals to
t heir enthusiasm for natural historical knowledges of the species characteristics
of companion animals and others (including lab animals) and the analytic
importance of lab animals, not least as models for human disease. In these
cases, their immersion in the naturalistic animal—both emotionally, as lay
people, and intellectually, as natural historians—served as a partial warrant for
their involvement in animal experimentation. Accordingly, they claimed that
they could never be cruel to animals because they loved them; they had such a
close relation with animals that they were best placed to assess whether the
animals were in discomfort or pain; they were the best readers of nonhuman
animal behavior—much more expert than antivivisectionists, for example.

The troubling of this divide between naturalistic and analytic animal/
approach has, of course, been further developed by Haraway in her notion of
companion species, as we have seen above. To reiterate, this concept is hybrid:
we have both the naturalistic animal connoted in “companion,” and the ana-
lytic animal connoted in “species.” On the one hand, the limulus serves as a
biomedical device that, because of its serum, tests for endotoxins in clinical
and research settings; on the other, the horseshoe crab is admired as a “living
fossil” and a natural historical phenomenon (as will become clearer below).

As noted, for Haraway the concept of the companion species serves as a
“pointer to an ongoing becoming with.” Companion species are thus rela-
tional, emergent from their intra-actions with one another (Barad, 2007).
And that intra-action is both subjective and objective (to the extent that these
terms apply anymore). Thus we need to see such companionship in the con-
text of, for instance, shared corporeal conditions (e.g., the commonalities of
immune response between humans and dogs); the always already historically
situated cultural and economic asymmetries between species; and the phe-
nomenological characteristics of interaction that include dimensions such as
the element of surprise, shared risk, reciprocity, and respect. In sum, the notion
of companion species invokes the idea that its constitutive relations are situ-
ated, mediated, and constantly performed.

In relation to the horseshoe crab, we can ask how we take into account this
nexus of issues in a way that allows us to imagine it as a companion species, to
recognize our intra-activity with it, and thus to accord it the respect “it”
deserves. This analytic frame might seem to be reinforcing the divisions
between human and nonhuman animals. Our aim, through this reflection,
however, is to show how human and nonhuman animals partially emerge
from their relations, thereby troubling that very divide. In the process we
need to question whether companionship entails the copresence of the com-
panions (despite the etymology of “companion”), or at least to query the
quality of this copresence. This brings us back to the motif of companionship as “together at table.” What does this mean in relation to the horseshoe crab in terms of copresence, the nature of the table, and the stuff on and around it?

I. Who Sits at the Table? Crabs, Researchers, Biotech

It is time to check amounts on hand, estimate the needs for the coming year, look at the calendar for the date of the full moon at the end of May or beginning of June and study the tide tables to learn when high tide will occur along the Cape shore of Delaware Bay in southern New Jersey. These bits and pieces of information must be assembled in our regular preparations for the trip to collect that beautiful blue blood of the horseshoe “crab,” *Limulus polyphemus* (Boyden, 1967, p. 7).

Mabel Boyden, biologist and staff member of the Serological Museum at Rutgers University from the 1940s to the 1970s, collected the serum of the horseshoe crab, *Limulus polyphemus*, over a couple of years from the New Jersey shores. Her collecting endeavor entailed a twofold task. On the one hand, the limulus serum was obtained in order to be integrated into the museum’s systematics collection of bloods. On the other, it was collected in order to be distributed to researchers in the biomedical field. While the systematics collection came to an untimely end in the early 1970s (and limulus blood samples along with other blood were probably thrown away), the biomedical world has come to, and continues to, rely on the limulus test developed from the serum of the horseshoe crab.

Mabel Boyden was herself fascinated by the substance she collected for the museum and for others, perhaps in part because of her awareness of the myths that surrounded blue blood and its role in the determination of social origin. Blue blood, she wrote, “is a figment of the imagination to most people—supposed to have something to do with special privileged lines of ancestry” (Boyden, 1967, p. 7). Yet, she knew better and conceded that “(e)ven to some biologists, it may be academic—some invertebrates are supposed to have it as the texts may state” (Boyden 1967, p. 7). Thus, while blue blood connotes privileged ancestry, it is also typical of at least some nonhuman animals.

Mabel Boyden drew a distinction between different biologists—crudely, those with a natural historical appreciation of limulus and those without. In a longish account about her annual trips to harvest the horseshoe crab blood, she wrote: “[U]nless the biologist frequents the seashore, and knows well the animals which live in the coastal waters, he [sic] may never have seen blood that is a deep blue, unmistakably so” (Boyden, 1967, p. 7). Hinted at here is a
privileging of those who were able to see the blood—or, more broadly, who had a practical and natural historical engagement with the crab. By contrast, she gently and tacitly teased the experimenters in the lab—a group on the verge of huge expansion with the rise of experimental biomedicine—who did not possess this deep knowledge about the biological material Boyden collected. Her statement enacts an implicit claim that at a time when laboratories were growing bigger and proliferating, and the naturalists were on the institutional retreat, so to speak, the knowledge about naturalistic and natural historical animals in the field continued to hold insights that would become lost with the success of laboratory-based experimental bioscience.

As if to stress the value of the horseshoe crab, Mabel Boyden went on to describe the longevity of the strange creature—the “living fossil,” as it were—and to show that its traces went much further back than those of human ancestors. “The horseshoe crabs are as much living fossils as the Coelacanths are, and at times they are much more common” (Boyden, 1967, p. 7), she wrote in her report (Fig. 2).

Mabel Boyden and her colleagues had good reasons to collect the blood of the horseshoe crab even before it had become famous in the LAL test application. Biomedical researchers had become interested in the serum for immunological experiments and applications in the wider field of cancer research (Levin, Hochstein, & Novitsky, 2003). Elias Cohen, a former student of Alan Boyden, for example, joined the staff of the Roswell Park Memorial Institute in Buffalo, New York, after he finished his studies at the Serological Museum and Rutgers University. He was happy about the amounts of limulus serum he received regularly through Mabel Boyden. “Limulus agglutinins were used to

![Figure 2. The bleeding process (Source: Serological Museum Bulletin 37, 1967)](image)
‘harvest’ tumor cells and leukocytes from the whole blood of patients with neoplasias,” he wrote in the Bulletin (Cohen, 1971, p. 4). His tight connections with the museum became visible when he happily acknowledged the institution in his writings. Mabel Boyden valued such positive statements not least because they legitimated her own work in the changing institutional circumstances. As she wrote in her article, referring to Cohen’s work, “This is but one illustration of how the teaching of serology at Rutgers has contributed to the study of medical problems” (1967, p. 10).

We have seen that at the table are a variety of human and nonhuman actors, each of which is ambiguous: we move from natural historians to biomedical scientists, from the serological taxonomy to the the technics of the LAL test to the aesthetics of blue blood, and from limulus as a resource to be harvested to a nonhuman animal of ancient habits. But we must not forget that these stories we are recounting—stories of technoscientific innovation and natural historical apprehension—do not circulate so widely. To be sure, there are popular and technical accounts of the horseshoe crab but, by and large, they lack the nuance we have tried to elaborate here. Our narrative, for all its peculiarity in tracing a history of the limulus through a particular scientific endeavor, can nevertheless contribute to an albeit slight revisioning of “companion species.”

II. What Is on the Table?

Boyden’s relation to the limulus at times seems almost romantic—she appreciates the “beautiful blue blood of the horseshoe ‘crab’ Limulus polyphemus” and she loves strolling over “mudflats and the beach to see what I can find of interest to a naturalist” (Boyden, 1967, p. 9). This was one aspect of her account, and it was tied to a practical engagement with the animal in its spawning habitat. Collecting the crabs took place in the dark, under moonlight, and had to be conducted as quickly as possible. It was hard and exhausting work, carrying the animals up the beach to the lab or trying to block off their escape. In the process, we learn that Mabel Boyden knew a lot about the animals she collected. She noted that:

Individuals are quite large for invertebrates, the females attaining weights of 15 pounds or more, the males being about one-fifth to one-third as large. It is of course easier to collect the blood from the females, and as much as a pint can be obtained from freshly caught individuals. (1967, p. 7)
Thus, the creatures could be admired for their physicality and their “resistance.” Even when Mabel Boyden saw them in terms of the amounts of blood they would produce, there was a certain admiration for their resilience: “If a partial bleeding is made, the organisms can crawl back into the water and move out into the depths” (1967, p. 7). They could “donate” and still survive.

Up to this point in her report, Boyden has not referred to the scientific uses to which limulus serum would be put. Her story is couched in language that is not shy of the poetical, referencing as it does historical reports and placing emphasis on nature and natural processes, on people’s interaction with the crabs, on the practical knowledge and intricate measures that would ensure a good catch.

In the day, following the moonlit capture, the blood extraction took place. As the focus of Boyden’s account shifts, so does the object that is under scrutiny. The crabs as well as the laboratory are made ready for the bleeding process. With a sharp knife the anonymous male operator makes incisions into the animals. “A gush of blood runs into the dish” (Boyden, 1967, p. 9). From now on, the thing to be treated is blood, clotting into a loose gel, turning into the deep and true blue blood. Further handling involves separation procedures—the serum is separated from the clot that goes to the birds; storage in a temporary fridge; transportation. Later, in the cold room of the Serological Museum,

\[\text{(t)he general procedure was to filter the blood through coarse filter paper as quickly as possible to remove all bits of clot. The next filtration was through coarse Seitz filter pads, viz. (1) K2 then (2) K5, then through the S 1 pads non-sterile, replacing them as often as necessary. (Boyden, 1967, p. 10)}\]

The technical demands of the purification process become paramount and attention is focused upon the production and bottling of pure, sterile serum.

This collection, Boyden makes apparent, was not simply for the benefit of the museum alone; it was to supply the needs of other scientists. When filtration processes produced the sterile liquid, “these lots were transferred to sterile vials or bottles, depending upon the specification of our orders” (Boyden, 1967, p. 10). Thus, the crabs are turned into materials, into precious fluids that are waiting to be shipped out.

Let us assume that on the table around which companions gather stand serving dishes, plates, cups, and cutlery. These are the implements of consumption, but also of exchange. To be sure, they are used to take in nourishment, but they are also present to transfer food among companions, and they are also there to mediate communication. When one speaks, it makes some
sort of sense not to fork food into one’s mouth; when one performs a story or presses home a point, the stabbing fork is a prop in a moment of emphasis. When we take a closer look at some of the careful accounts provided by actors in and around the Serological Museum in the 1960s, we can see that sitting with, exchanging materials and signs with the horseshoe crab, entails not only limulus serum and the technologies of its extraction but a proliferating array of concepts, imaginations, and utilities. Increasingly these make both thinkable and doable the prospect of converting more and more nonhuman animals and their substances into materials for the improvement of human health. The table is becoming cluttered with the stuff of novel biomedical tests and scientific experiments, the promises of biotech and pharma, and the plans of regulatory and medical spokespersons. In other words, the table settings are being redesignated as a range of novel values becomes visible. Limulus becomes less a companion and more a part of the feast held in celebration of the new experimental means of doing biology or ensuring the health of the human population. And yet, for all that, we would like to retain the echo of Mabel Boyden's wonder at the limulus in its corporeal, ecological, and natural historical strangeness.

III. The Table at Which Companion Species Sit Together

In recent years, the limulus has been the subject of regulatory attention. This is linked to the increase in the amount of blood collected (Levin et al., 2003), not least for biomedical use. Thus, protection of the species has been added to the conservationist agenda (Garland, 2004), despite routine assertions that bleeding is not fatal to crabs and that once returned to the water the crabs regenerate (Levin et al., 2003). But further, from the 1970s the extraction of limulus serum has become an industrialized procedure. As we learn from a *Nature* film (Argo, 2008) on the collection and bleeding of horseshoe crabs, it is not scientists but fishermen who presently catch the crab for “the doctors” waiting somewhere in the lab. Science itself has moved on from the collecting and extraction procedures: analytic work is done not on the animal but on the information its substances yield.

This short film furnishes some insight into the procedure of extracting limulus blood. The voice-over tells us that “crabs that are borrowed end up a couple of hours away at the Endosafe Laboratories in Charleton.” This is an “alien world,” according to the narrator, who describes the factorylike space in which the limulus “are given a rigorous cleaning.” The film shows that the cleaning procedure takes place in a sterile environment by workers in white lab coats. A whole apparatus is set up for the crabs. Hundreds of the animals
are lined up next to each other, resembling nothing less than a row of military helmets. With sterile gauze the animal is again cleaned for the puncture.

While the film does not present the detailed story of the private companies that have the facilities to “manufacture” the serum (Levin et al., 2003), the boundaries between production site and research lab seem blurred. As soon as the last grain of sand is cleaned off and any other leftovers of maritime life have been removed, the endeavor becomes a quasi-scientific one. After a hypodermic needle has been inserted and the blue blood has begun to trickle into the bottles that are fixed to the shells, a researcher enters the scene (Argo, 2008). He asks about a crab’s gender and demonstrates that he himself is quite capable of extracting the blood. For this, he uses an instrument that is symbolic for the medical context—a syringe. The blurring of the line between factory and laboratory suggests other ambiguities: the tension between the utility of the blood and the otherness of the limulus and between the innocence and harmlessness of these marine creatures and their apparent military “appearance,” signaled by the resemblance of their armor to military helmets and a close-up of their pincers.

Returning to our metaphor of companions at table, this short film about the horseshoe crab serves to throw into relief the fact that the meaning of the table itself is thoroughly complex. For example, the film evokes a sense of a business table where “deals” for the extraction of blue blood are done between crab and human, though it is the crab who clearly loses out, though apparently not always fatally. The film furthermore suggests the idea of the laboratory table where scientific knowledge and technoscientific procedure have come to be routinized. But the film also hints at something like a museum table that is part of a cabinet of curiosities—a surface around which humans gather to marvel at the strangeness of the blue blood, its ancientness and its uncanny relevance for human bodies.

The feeling of strangeness vis-à-vis this animal’s potent capacities had already been articulated in the 1960s, specifically in the context of the Serological Museum’s collection. If we return to the stories told in the Serological Museum Bulletin, we find, for example, Elias Cohen, a former student of Alan Boyden who was subsequently active in cancer research, expressing his surprise at the substance he was working with: “During such studies, one may reflect how ironic it is that the blood of crab-like creatures assists in the research of disease that derived its name after ‘Cancer’ the crab” (Cohen, 1971, p. 4). Even while using the blood in his experiments, he seemed to feel a certain unease at the coincidence of crab and cancer. That is to say, he was bemused by the seeming absurdity of the knot of connections that tied cancer the human disease and Cancer in the guise of the horseshoe crab, that linked these unlikeliest of—to use our terminology—“companions.”
Furthermore, when limulus became embroiled in the emerging biotechnology industry (that is, when the industrialization of the companions’ table got underway), a sense of wonder could still be expressed. Take the example of James Reno, who responded to Mabel Boyden’s article on collecting the limulus. He was a representative of this developing industry, being a researcher at the medical company Bioquest, Becton and Dickinson⁴ (Becton, Dickinson & Company). Back in the 1970s, Reno drew on Mabel Boyden’s account to advocate the limulus test:

> The need for a test for endotoxin is clear, the pathological significance of gram negative sepsis in man is indeed critical and the need to detect such at a very early point is obvious; it is also hoped that someday the Limulus test or a test similar to it will replace the standard rabbit pyrogen test for the use of screening pharmaceuticals and injectible products. (1973, p. 7)

Yet this technical proposal was tinged with wonder regarding the substance on which medicine would come to rely:

> It is paradoxical that man, who generally considers himself as the “blue blood” of the animal world, may some day have his life saved due to a test which utilizes a true “blue blood” of the sea—Limulus polyphemus, the “horseshoe crab.” (1973, p. 7)

Indeed, Reno twice refers to the blue color of horseshoe crab blood. The contrast between the supposed blue-blooded aristocracy of the human and the blue-bloodedness of the “primitive” horseshoe crab reflects another irony: that the “superiority” of the human, manifested in its technical ingenuity, is undermined by the very dependence on the blue blood of an “inferior” species. Reno’s wording does not directly claim this. He makes it clear that it was the test that demonstrated human superiority: after all, humans were clever enough to utilize the blue blood of the crab in the first place. Nevertheless, there are hints that the human is not quite inventive enough: it cannot replace limulus outright; it is still beholden.

In their different ways, James Reno, Elias Cohen, and Mabel Boyden were infused with a sense of wonder. They wonder at the relation they have with the horseshoe crab, at the ironies entailed in a relation that straddles the scientific, the technical, the medical, the economic, the corporeal, the aesthetic, the sensual, the mythical, and the symbolic. The table at which they sit with the limulus case is thus a complex and multifarious one indeed—one that may take variously and simultaneously the form of the hospital, the factory, the biomedical research unit, the beach, and the tree of life.
Conclusion: Companion Species at a Distance

In the foregoing sections we have attempted to trace some of the complexity and ambiguities that can be recovered from a very particular history of *Limulus polyphemus*, the horseshoe crab. By elaborating the metaphor of companions at table, we have reflected on the shifting, ambiguous versions of human and limulus that share bread, on the shifting, ambiguous activities mediated through the proliferating implements of “dining,” and on the shifting, ambiguous configurations of the table itself. What we have detected is a relation in which limulus is increasingly divested of its wondrousness as it becomes, through its incarnation as a test system, ever more tightly embroiled in a medico-industrial complex. And yet, at the same time, that wondrousness echoes through our story from past to present, most especially as natural historical aesthetics and sensualities, and as unsettling mythological coincidences that threaten to upset evolutionary hierarchies.

The horseshoe crab is not, for most people, a good candidate for the status of companion species. The seeming distance between human and horseshoe crab—evolutionary, historical, social—suggests associations that are thin, alien, and highly distanciated, as opposed to the thick, “intimate,” short (though always complex and surprising) associations that characterize the relations between, iconically, human and dog. Even the limulus’s role in LAL does not make for companionship, for it is a role nowadays mediated through an industrialized process. And yet, we have insisted, there are echoes of a more complex relation to be found in the fragmented musings of scientists as they tried to grapple with the natural historical complexity of limulus, or the mysteries of its biomedical utility and the ironic connotations of its blue blood.

If we are to think limulus as a companion species—and, as we mentioned at the outset of this paper, we want to do this in order better to value and think the complexity of limulus—then we must rework that concept a little. For Haraway, companion species imply a “becoming with” that in turn implies some form of reciprocity as human and nonhuman animal coemerge. But there is little by way of reciprocity in the relation between people and horseshoe crabs.

There is a process of coemergence, however, even if this is largely manifested within human-oriented assemblages of LAL, genealogy, or natural history. What limulus “is” changes—as its embroilments shift, so too does its ontology (Mol, 2003).

The first thing we must address is the fact that the “companionship” afforded by limulus is a mediated one. Of course this applies to any companion species: the dog is likewise a species complexly mediated through breeding, history, economy, culture, technology, and so forth. For the horseshoe crab, however,
this mediation is, for want of better terms, a more “elongated” or “distanciated” one. Instead of the intimacy of human-canine companionship, with limulus, there is a distanciated copresence. This distance operates on several levels: the evolutionary distance between “living fossil” and recent mammal; the biological-ecological distance between ancient marine creature and modern human terrestrial society; the historical distance between the natural historical animal of the 1950s and the industrialized source of LAL in the 2000s.

Yet, as we have argued, there are ways in which this distanciation can be “overcome.” Haraway notes how companion species “become-with,” coemerge through their complex, ongoing interactions. It is harder to envisage such a version of becoming between limulus and human. We can adapt this valuing of process and emergence, however: instead of “becoming with” we can perhaps talk of “becoming because of.” The distanciated copresence of limulus has enabled the emergence of particular sorts of humans. Most obviously, “because of” limulus, humans have “become” less prone to infection and disease: the horseshoe crab’s integration into a medico-industrial complex that extracts, purifies, and circulates its serum has meant that we have become better protected from endotoxins. Furthermore, the horseshoe crab as a source of goods that circulate in economic markets also contributes to the success of the pharmaceutical industry. But, further, and most important in the present context, the horseshoe crab’s translation into the LAL test comprises and defines a sort of background technoscientific condition in which humans are “safe” enough to be able to “become with . . .” other organisms, entities, configurations, and so on. In other words, “becoming because of” limulus facilitates a “becoming with” elsewhere.

This “becoming because of” also takes other forms, however. From our analysis above, we highlight the “becoming because of” enabled by the limulus’s blue blood and its complex materialization and signification. As we have seen, scientists’ somewhat bemused accounts of the ironies of blue blood as simultaneously a marker of the “primitive” and the “aristocratic” suggests a different field of “becoming because of”—one in which genealogy and evolution are reversed or confused. Here, the human aristocratic sense of superiority, arrogance, or hubris is “undercut” (or at least troubled) by the blue blood of limulus, which signifies both its position as the “aristocrat” of endotoxin detection, and human dependence upon it. Here, “becoming because of” is a heterogeneous process that bundles together the biomedical, the mythical, the genealogical, the evolutionary, the social. What emerges out of these analyses, ideally, is a human that is more modest in its relation to nonhuman animals. Furthermore, this suggests the idea—based on Haraway’s account of human-
nonhuman animal conversation—of a “reciprocity” that lies not within the sentimental anthropomorphizing of animals but in a deeper understanding of the interactions between human and nonhuman, biochemical-natural substances, lab processes, medical complexes, and embedded technoscientific humanness.

A corollary to this account of becoming concerns the affective and temporal dimension of interactions between companion species. Crucially, for Haraway these interactions are marked by “surprise”: the unexpected that arises in interaction renders it eventful, unpredictable, even “delightful” and “dangerous.” For most people, such an affective and temporal relation is unlikely to emerge in relation to limulus. The intensity, speed, and reciprocity of interaction necessary for such surprise is somewhat less in evidence. There is still an affective dimension to human-limulus interaction, however, even if its temporal rhythms are more extended. This is the relation of what we might tentatively call “wonder.”

Throughout our recovered history of limulus we have detected the signs of “wonder”—in Mabel Boyden’s natural historical account of collecting horseshoe crabs; in Elias Cohen’s ironic musings on Cancer, cancer, and crab; and in James Reno’s thoughts on convoluted genealogical-evolutionary significations of blue blood. Moreover, we see evidence of a contemporary version of this wonder in the very existence of the *Nature* film of limulus harvesting and bleeding, and its YouTube posting. If we were to attempt a summary phrase which might connote this sense of wonder, it might read: “Why on earth can limulus do what it does in relation to humans?”

We are, of course, aware that “wonder” hardly does justice to the complexity of the affective relations of human toward limulus. After all, it must accommodate a sense of the sublime, of bemusement, of coincidence, of “ungraspability,” of ambiguity, of irony. Nevertheless, as a heuristic term it will serve as another affective dimension of companion species to add to that of “surprise.”

In sum, we have expanded the idea of companion species to encompass “distanciation,” “becoming because of” and “wonder”—all this in order to better value limulus. It goes without saying that such a valuation ends up being not a little anthropocentric—after all, it is unclear what precisely the horseshoe crab gets out of all this. Nevertheless, the distanciated companionship of the horseshoe crab can be cherished because it confuses the commonsensical categories that feed human “superiority” and signals the complex, extended relationalities out of which the “human” emerges. It is to be valued because it evokes the “other” at the heart of the “same” of human identity. On this score, limulus is a sort of initial test case, or preliminary model, for the
many other nonhuman animals that are seemingly alien, distanciated, and abjected.5

Notes

1. We are careful throughout to note that the distanciation and exoticism of the horseshoe crab is comparative. There are of course lay groups that have considerable experience with limulus—tourists, local residents, fisherfolk. Our simple point is that for very many people (despite some efforts at popularization), limulus remains an obscure and mysterious species.

2. We say “partial” emergence because both humans and nonhuman animals emerge ongoingly from a multiplicity of relations. For the latter, these include ecological relations; for the former these include, additionally, gender and class relations.

3. In e-mail correspondence, Erika Gorder from the Rutgers University archives referred to the following information from Chuck Martin, a former researcher at Rutgers: “As far as the Serological Museum: That is long gone. The refrigerator containing all of the samples was in my ‘new’ laboratory when I moved from Douglass in 1984. Someone had unplugged it and when I opened it the smell was awful, all of the bloods had deteriorated and were thrown away” (E. Gorder, personal communication, August 25, 2008).

4. It continues today as Becton, Dickinson & Company, a leading global medical technology company.

5. We have not spelled out in more detail broader political implications of this expanded version of companion species because it is highly problematic to derive an explicit politics from an ontology (Soper, 1995) of, in this case, human-nonhuman animal relations. Unfortunately, nothing in our account a priori precludes exploitation of limulus. What it does do, however, is open up a slightly new space for the discussion of the treatment of the horseshoe crab and the possibility of a new politics.

References


