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Emil August Göldi (1859–1917) – a life between Switzerland and Brazil

Deutsche Zusammenfassung

Mit diesem Beitrag soll die berufliche Laufbahn und das wissenschaftliche Werk des Schweizer Naturforschers Emil August Göldi beleuchtet und gewürdigt werden. Göldi war einer der Pioniere in der biologischen Erforschung des Amazonasgebiets – eines Hotspots der Biodiversität. Auch über die Biologie hinaus spielte er eine bedeutende Rolle für die politischen Beziehungen zwischen Brasilien und der Schweiz.

Bezug zu Bern

Für das naturwissenschaftliche Umfeld in Bern ist Göldi in vielfacher Hinsicht von Bedeutung: Er lehrte ab 1907 erst als Privatdozent, dann als Extraordinarius für Tiergeografie und Tierbiologie an der Universität. Seine private Sammlung und eine viel umfangreichere Parallelsammlung von Insekten und Wirbeltieren des Staatsmuseums von Pará werden im Naturhistorischen Museum der Burgergemeinde Bern aufbewahrt, in dessen Aufsichtskommission er 1911 Einsitz nahm. Er war seit 1906 Mitglied der Naturforschenden Gesellschaft und ab 1910 bis zu seinem frühen Tod im Juli 1917 deren Präsident. Auch dem Entomologischen Verein Bern stand er ab 1910 als Präsident vor.

Biografie

Emil August Göldi kam 1859 in Schlatt bei Nesslau (SG) zur Welt. Er stammte aus einfachen Verhältnissen; sein Vater Johannes Göldi (1833–1901) hatte in seiner Jugend noch als «Schwabengänger» jenseits des Bodensees das Sommerhalbjahr hindurch Vieh gehütet, dann aber eine Ausbildung zum Lehrer erhalten. Im Jahr von Emils Geburt wirkte er an der Oberschule in Nesslau, später leitete er als Reallehrer ein Knabeninstitut in Neuhausen (SH).

Nach dem Abitur am Gymnasium Schaffhausen 1879 weilte Emil Göldi in Neapel, u.a. an der marinbiologischen Station, bevor er das Studium der Zoologie und Vergleichenden Anatomie in Leipzig und Jena begann. Seine Dissertation schloss er 1884 ab.

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1884 nahm er ein Stellenangebot als Vizedirektor der zoologischen Abteilung am brasilianischen Nationalmuseum in Rio de Janeiro an. Nach dem Sturz der Monarchie 1889 verlor er seine Stelle, worauf er sich auf das Landgut seines Schwiegervaters im Orgelgebirge (bei Teresópolis, nördlich von Rio de Janeiro) zurückzog. Dort beteiligte er sich an der Gründung einer neuen landwirtschaftlichen Kolonie (*Colônia Alpina*) mit Schweizer Auswanderern; das Projekt scheiterte allerdings aus verschiedenen Gründen. Der als Leiter vorgesehene Ingenieuragronom Karl Paganini (1868–1890) verunfallte kurz vor seiner Abreise aus der Schweiz tödlich auf einer Bergtour am Säntis. So musste sich Göldi selber dieser Aufgabe annehmen (was ihm seitens der Siedler den Namen «Colonistentyrann» einbrachte). Daneben beschäftigte er sich in dieser Zeit als Privatgelehrter, sammelte Vögel und andere Tiere und schrieb zwei umfassende Monografien über die Säugetiere bzw. die Vögel Brasiliens – beide in Portugiesisch abgefasst.

Durch das Werk über die Säugetiere wurden die brasilianischen Behörden wieder auf ihn aufmerksam. Der Gouverneur des Staates Pará, am Amazonas gelegen, berief Göldi an das dortige Staatsmuseum, welches sich seit längerer Zeit in einem desolaten Zustand befand. Mit seiner Familie zog Goeldi 1894 nach Pará (heute Belém) und engagierte sich mit seiner ganzen Energie für den Wiederaufbau der einst angesehenen Institution. Für die verschiedenen Fachgebiete – Botanik, Geologie, Präparationstechnik, den Zoologischen Garten – holte er junge Wissenschaftler und Fachkräfte aus der Schweiz, Deutschland und Österreich ans Museum. Schon nach wenigen Jahren genossen das Museum und seine Forschungsabteilung wieder hohes Ansehen in der ganzen wissenschaftlichen Welt.

In diese Zeit fällt eine Episode, die Göldi nochmals von einer ganz anderen Seite zeigt. Brasilien lag mit Frankreich seit Jahren in einem Grenzstreit um die nördlich des Amazonas gelegene Provinz Amapá. Im Friedensvertrag von Utrecht (1713) war der Fluss Oiapoque als Grenze zwischen dem damals noch portugiesischen und dem französischen Kolonialgebiet festgelegt worden. 180 Jahre danach stritt man sich darum, welcher der verschiedenen in den Atlantik mündenden Flüsse der richtige Oiapoque sei. Um 1890 gaben Goldfunde im Gebiet dem Konflikt neue Aktualität, die in einem blutig endenden Angriff französischer Milizen auf eine brasilianische Siedlung gipfelte. In dieser Situation empfahl Göldi dem Gouverneur von Pará, den Schweizerischen Bundesrat als Schiedsgericht im Territorialstreit anzurufen und schrieb darauf den Bundespräsidenten in dieser Sache gleich selber an. Was ihn dazu veranlasste, ist bis heute nicht klar. Jedenfalls hielt sich Göldi in der Folge längere Zeit in der Schweiz auf, um die Experten des bundesrätlichen Schiedsgerichts zu kontaktieren. In Bern lernte er damals Theophil Studer (1845–1922) kennen, der den Lehrstuhl für Zoologie an der Universität inne hatte und gleichzeitig die zoologische Abteilung am Naturhistorischen Museum leitete. Diese Begegnung war wohl entscheidend dafür, dass Göldi später seine Sammlungen dem Naturhistorischen Museum anvertraute und 1907 selber mit der Familie nach Bern zog. – Der Bundesrat entschied den Territorialstreit im Jahr 1900 zugunsten Brasiliens. Darauf benannten die Behörden von Pará ihr Staatsmuseum um in «Museu Paraense Emílio Goeldi», als Dank für Göldis Beitrag zum Erfolg im Streit um Amapá und in Anerkennung seiner Leistung beim Wiederaufbau der Institution.

Würdigung seiner Arbeit

Als Zoologe zeigte sich Göldi als äusserst vielseitig, sowohl bezüglich der Forschungsrichtungen wie der Organismengruppen. Allerdings war dies in seiner Zeit nicht aussergewöhnlich, denn die frühe Spezialisierung, wie wir sie heute im Biologiestudium kennen, wurde erst in der 2. Hälfte des 20. Jahrhunderts üblich. Seine über 200 Publikationen befassen sich denn auch mit fast allen Wirbeltiergruppen sowie einer Vielfalt von Insekten und anderen Wirbellosen. Die Entdeckung und Beschreibung neuer Arten war immer wieder ein Thema, aber die Mehrheit der für ihn neuen Formen überliess er andern Spezialisten zur Beschreibung. Durch diesen Austausch von neuen Informationen und Exemplaren war Göldi mit vielen andern Wissenschaftlern an den führenden Museen der Welt vernetzt.

Da zum Aufgabengebiet des Museums in Pará auch die Ethnografie gehörte, arbeitete sich Göldi selber in diese Disziplin ein und schrieb Berichte über indigene Stämme, mit denen er im amazonischen Urwald in Berührung kam. Mit der Untersuchung «altindianischer» Gräber und der darin enthaltenen Begräbnisurnen begab er sich sogar in das Gebiet der Archäologie.

Bei aller Vielseitigkeit sind drei Schwerpunkte in seiner wissenschaftlichen Arbeit zu erkennen. Taxonomie und Biogeografie – die Beschreibung neuer Arten und die Erforschung ihrer Verbreitung – war eine der Hauptaufgaben des Staatsmuseums in Pará, dem er von 1894–1907 vorstand. Nach der Rückkehr in die Schweiz – mit einer weitgehend bekannten Artenvielfalt – trat dieses Forschungsgebiet in den Hintergrund. Allerdings widmete er der heimischen Wirbeltierfauna mit «Die Tierwelt der Schweiz in der Gegenwart und in der Vergangenheit» ein über 600 Seiten umfassendes Werk und stellte diese in einem historisch-biogeografischen Rahmen dar.

Die Frage nach der Homologie von Organen und deren Abwandlung in verwandten Tiergruppen hat Göldi Zeit seines Lebens beschäftigt. Als Student in Leipzig und Jena, hier zeitweise als Assistent Ernst Haeckels, war er mit der Evolutionstheorie aufgewachsen und deshalb gewohnt, in evolutiven Zusammenhängen zu denken. In seiner Dissertation ging es um die Homologie von Skelettelementen des Kopfes und des Schultergürtels verschiedener Fischarten. In Bern lehrte und publizierte er über die Homologie der Mundteile der Insekten und anderer Gliederfüssler – ein Thema, das auch heute noch hohe Aktualität hat, liegt darin doch einer der Schlüssel für das Verständnis der Verwandtschaft zwischen den verschiedenen Arthropodengruppen.

Der dritte Arbeitsbereich war die angewandte Zoologie – die Erforschung und Bekämpfung schädlicher Organismen. Hier sind Göldis gesellschaftlich bedeutendste Beiträge zu suchen. Als frischgebackener Universitätsabgänger untersuchte er im Auftrag des Kantons Schaffhausen die Blutlaus, die um 1870 aus Nordamerika eingeschleppt worden war und nun die Obstbäume der Region massiv schädigte. Kurz darauf beschäftigte er sich mit dem Erreger der berüchtigten Kraut- und Knollenfäule der Kartoffel. In Brasilien erforschte er im Rahmen eines staatlichen Auftrags eine verbreitete Krankheit der Kaffeestauden und beschrieb eine neue Nematoden-Art (Fadenwurm) als deren Erreger. In Pará erforschte er

die Mücken und damit die Überträger des Gelbfiebers – einer Tropenkrankheit, die nicht zuletzt auch unter Göldis Mitarbeitern zahlreiche Todesopfer gefordert hatte. Die «sanitarisch-pathologische Bedeutung der Insekten» bildete denn auch ein Thema seiner Vorlesungen in Bern.

Über die Tätigkeit als Forscher und Lehrer hinaus erwies sich Göldi als versierter Wissenschaftsmanager. Er entwickelte Forschungsprogramme und gab Anstoss zu Expeditionen ins unerforschte amazonische Hinterland. Mit dem Aufbau des Staatsmuseums in Pará – das Museu Paraense Emílio Goeldi ist heute das zweitgrösste Naturmuseum Brasiliens – hat er eine weltweit renommierte Institution geschaffen, die eine führende Rolle in der Erforschung Amazoniens einnimmt. Durch den Beizug von Wissenschaftlern aus Europa und den wissenschaftlichen Austausch mit Institutionen in der westlichen Welt stellte er früh die internationale Vernetzung seines Museums auf professionellem Niveau sicher. Immer legte er auch Wert darauf, wissenschaftliche Erkenntnisse und den Naturschutzgedanken unters Volk zu bringen, durch Ausstellungen, die Errichtung eines zoologischen Gartens sowie mit Aufrufen und Petitionen zum Schutz von Schildkröten oder der weissen Reiher.

Für Göldi war die Wissenschaft nie blosser Selbstzweck. Zwar faszinierten ihn grundsätzliche biologische Fragen wie etwa die Geschlechtsbestimmung bei Bienen oder die Funktion von Insektenstaaten. Die Nutzenanwendung naturkundlicher Erkenntnisse sollte aber der Allgemeinheit zu gut kommen. Als Forscher sah er sich im Dienst der Institution und der ihr übergeordneten Gemeinschaft, in deren Auftrag er tätig war. So lässt sich auch sein Engagement im Territorialstreit um Amapá verstehen: Dem Naturforscher ermöglichte es die Expedition in unbekanntes Neuland, aber die dabei gewonnenen Erkenntnisse nutzte er dazu, dem Staat Pará zum Gewinn des umstrittenen Territoriums zu verhelfen.

Introduction

Brazil and Switzerland share a long history of cultural relations. Among the better known instances of this relationship are the farming colonies, established in various places of the vast Brazilian territory since the 19th century. They welcomed many thousands of Swiss migrants. Less familiar are the activities of Swiss painters and photographers, who travelled around Brazil or followed the migration waves to that country. Among them, we find Abraham-Louis Buvelot (1814–1888, a famous landscape painter), William Michaud (1829–1902, known for his paintings of the Brazilian Atlantic Forest) or Wilhelm Gaensly (1843–1928, who created magnificent photographs and postcards of the Brazilian landscape and cities), most of them not yet duly recognised. This lack of recognition also applies to naturalists and scientists who elected the tropical country as the focus of their professional interests, as e.g. Johann von Tschudi (1818–1889), Carl Hieronymus Euler (1834–1901), Leo Zehntner (1864–1961), Jacques (or Jakob) Huber (1867–1914) or Gottfried Hagmann (1874–1946). The better known and studied among them are certainly Adolf Lutz (1855–1940) and Emil August Göldi (1859–1917) (Figure 1). Son of Swiss immigrants established in Rio de Janeiro, Lutz is the subject of a major recent documentation project with a twelve-volume publication of his entire work, complemented by analytic articles (BENCHIMOL 2003; BENCHIMOL ET AL. 2003; SANJAD 2010a). Born in the canton of St. Gallen and graduated from Jena, Göldi (also spelt Goeldi) was a researcher at the two foremost natural history

museums in Brazil – the National Museum (Museu Nacional) in Rio de Janeiro and the Emilio Goeldi Museum of Pará (Museu Paraense Emílio Goeldi) in Belém, State of Pará, named after him since 1900 in his honour (GÜNTERT ET AL. 1993, MORGENTHALER 1993; SANJAD 2009, 2010b).

In this paper we analyse Göldi's professional career and oeuvre – as one of the foremost biologists involved in the study of the Amazonian forest and considered by many as one of the pioneers of South American tropical research. Göldi's bio-



Figure 1: Emil August Göldi (1859–1917) around 1895. Unknown photographer. Glass plate negative. Photographic Collection, Goeldi Museum, Belém, Brazil.

graphy can be studied not only in the context of Brazilian-Swiss relations but also within the wider framework of intellectual exchanges. He was certainly one of the passeurs culturels so well described in the volume edited by BÉNAT-TACHOT & GRUZINSKI (2001), namely as a historically active subject who contributed to the genesis of a global scientific culture by means of a transnational trajectory from the Swiss-German to the Latin American scientific world – and back. Particularly interesting for the reader of this journal, he was a member (since 1906), vice-president (1909) and president (1910) of the Society of Natural History of Bern (Naturforschende Gesellschaft in Bern).

Our purpose is not new, for since ROSENBERG's classic 1988 essay on the relationship of context and content in the history of sciences, many science historians have dedicated themselves to biographies of scientists as connectors towards the analysis of wider processes, such as the circulation of ideas, the transmission and adaptation of institutional models and the creation of scientific networks at local and international levels (PORTER 2006; NYE 2006). What we propose as novel here is the emphasis given to Brazilian-Swiss relations in the field of science in the transition between the 19th and the 20th centuries. This allows for the examination of interesting themes such as the leading role of the Swiss in the construction of scientific knowledge with regards to the Amazonian region.

This article comprises three sections. First we present a biographical sketch of Göldi with emphasis on the period in which he directed the museum that today bears his name, then we offer an overview of his scientific oeuvre, particularly of his work in Brazil, and finally we make some comments on his political, scientific and museological legacy, including his contribution in making Amazonia a hot spot that is active to this day – that is a geographic space that demands the attention of governments and scientists by reason of its biodiversity assets, its planet-wide ecological function and the environmental services it provides.

Göldi's Life – Science beyond frontiers

The formative years

Emil August Göldi was born on 28 August 1859 in Schlatt near Nesslau as a citizen of Sennwald (St. Gallen), a son of Johannes Göldi and Anna Margretha Kunz. Soon after his birth, his father worked as a teacher of natural history in various towns in northeastern Switzerland, ending up as the director of a boys' school in Neuhausen (Schaffhausen). Göldi completed his secondary schooling in the city of Schaffhausen and passed the high school leaving exam (Matura) in 1879 (Figure 2). By that time, at his father's encouragement, he published his first relevant work: a catalogue of the birds of the canton of Schaffhausen in the «Journal für Ornithologie» (GÖLDI 1879). At the tender age of 20, Göldi preten-

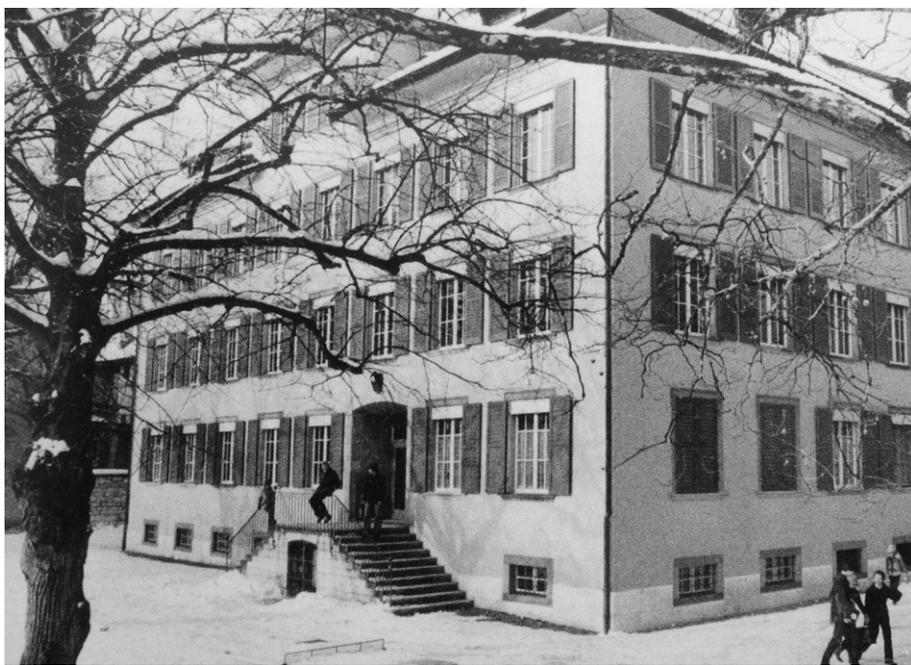


Figure 2: The old High School (Kantonsschule) in Schaffhausen, where Emil Göldi attended classes between 1877 and 1879 (WANNER 2001:11).

tiously signed his articles as «Professor» and showed a keen interest for taxonomy and museological techniques.

After his Matura, Göldi went out looking for work and educational improvement. He entered the Society of Natural Science of St. Gallen (St. Gallische Naturwissenschaftliche Gesellschaft) and the Society of Natural Science of Schaffhausen (Naturforschende Gesellschaft Schaffhausen), with which he would keep ties for the rest of his life. In the cantons of Neuchâtel and Bern, he studied French and worked as a supply teacher. He wrote for popular scientific journals on common beliefs related to plants and animals, history of science and accounts of travels to Lake Biel and the Gulf of Naples (GÖLDI 1880a, 1880b, 1880c, 1880d, 1881a). Göldi arrived in this latter city in September 1880 to study Italian, and in April of the following year he joined the Zoological Station of Naples, today the «Stazione Zoologica Anton Dohrn di Napoli». Anton Dohrn (1840–1909) had established and turned this scientific institution into a renowned centre for marine biology, modern techniques of microscopy and experimental research. Göldi remained three months at the Station and conducted ornithological and ichthyological studies. In his second paper for the «Journal für Ornithologie» he comments on the collections held in Naples and on the distribution of birds along the Gulf (GÖLDI 1881b).

By late 1881, Göldi attended classes at the universities of Leipzig and Jena, in Germany, in the course of Zoology and Comparative Anatomy. Both cities were important centres for evolutionary studies. In Leipzig, Göldi gave lectures and wrote on animals of the Tertiary, on the migration of European birds and on the cultivation of marine sponges. In Jena, he became an assistant of the Institute of Zoology (Zoologisches Institut), directed by Ernst Haeckel (1834–1919) at that time, and he defended his dissertation in 1883, with Wilhelm August Oskar Hertwig (1849–1922) as his supervisor. Broadly, it concerned the homology¹ of some bones of the skull and the pectoral girdle of three species of «armoured» fish (GÖLDI 1884).

Back in Switzerland in 1884, Göldi began research in applied zoology, a field in which he would later become prominent. That area was developing fast in Germany, in France and in the United States, sponsored by governments and associations of agricultural producers. Greater closeness between science and economy allowed a better control over pests and diseases, the development of management techniques, the improvement of industrial processes and the expansion of farming activities. With that goal in mind, Göldi was commissioned by the Schaffhausen government to investigate a small insect that was causing enormous losses to apple farmers, the woolly aphid (Blutlaus). After a few months of work, he identified the most common species of the insect as *Schizoneura lanigera*, nowadays *Eriosoma lanigerum* (Hausmann), described the damage it caused and proposed measures to protect the crops. He presented his results to the Agricultural Society of Schaffhausen and had them published the following year by the local government (GÖLDI 1885). Shortly afterwards, he came out with a new paper, now on the genus *Phytophthora*, a group of water moulds (Oomycetes, Ei- oder Scheinpilze) of great agricultural interest: these single-cell creatures were responsible for many plant diseases such as crown and root rot of potatoes (Kraut- und Knollenfäule). Their control was difficult, as their reproduction can be asexual, a matter specifically addressed by GÖLDI (1887).

The tropics as an academic choice

Göldi was busy with those issues, when he received an invitation from the director of the Brazilian National Museum of Natural History, Ladislau de Souza Mello Neto (1838–1894), to work at that institution. In November 1884, at the age of 25, he disembarked at Rio de Janeiro, lured by the opportunity to study the sumptuous nature in the tropics. In February of the following year, he was tenured as the deputy director of the Department of Zoology. He remained there for six years and published over thirty papers, including articles, research notes, reports and chronicles. He wrote about many animal groups – reptiles, birds, mammals, insects,

¹ Homology is the similarity of biological structures of different organisms, which is interpreted as an evidence of common ancestry.

spiders and crustaceans, sometimes on their evolutionary aspects. Thus, he kept a diversified interest in taxonomy, life history and applied zoology, as he had done previously in Europe. Göldi also devoted himself to recording weather data, to translating scientific texts and to doing historical research, particularly on authors he considered important for the knowledge of the Brazilian fauna.

These publications reveal a scientist well aware of the local society and interested in domains tangential to his own discipline, such as economics and anthropology. They also show a certain attitude of leadership that Göldi would later assume in scientific matters, including those related to the conservation of natural resources. Especially interesting in that aspect are the two articles he published on the turtles of the Amazonian basin in collaboration with João Martins da Silva Coutinho (1830–1889), the main Brazilian partner of Louis Agassiz (1807–1873). In the first text, Göldi describes the most common species, their feeding and reproductive habits, the methods adopted by indigenous and riparian communities for their hunt, the gear employed, cooking procedures, etc. He concludes with an appeal against overhunting and the unchecked picking of their eggs, which he classifies as an act of «unacceptable savagery», that only a governmental incentive for the farm-breeding of turtles could stop (GÖLDI 1886a)². In the second paper, he describes the species *Podocnemis coutinhii* (Figure 3), popularly known in

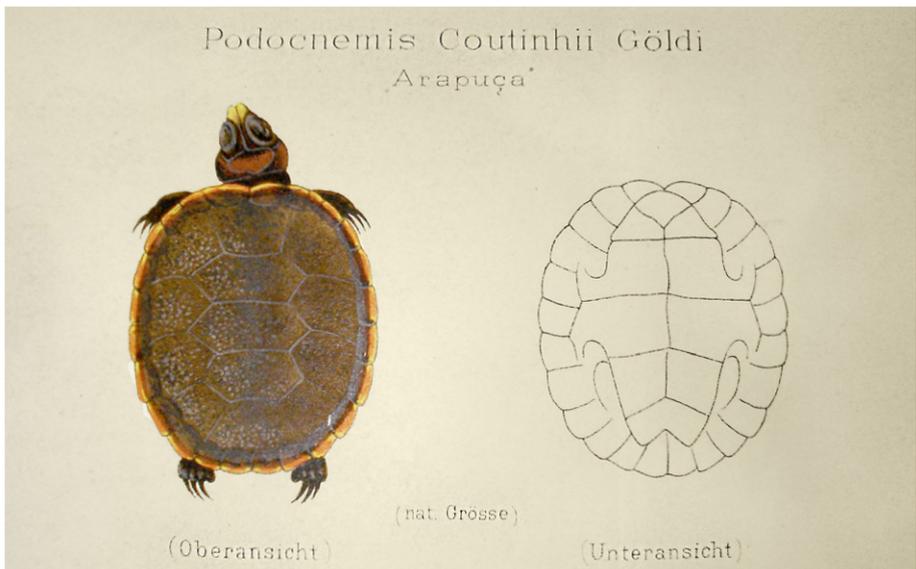


Figure 3: *Podocnemis coutinhii* Göldi, 1886, currently known as *Podocnemis erythrocephala* (Spix 1824).

² The visionary suggestion of Göldi was adopted by the Brazilian government many decades later (in the 1960s) with the protection of spawning areas, the hunting ban of endangered species and fostering farm-breeding.

Brazil as «arapuçá» and nowadays synonym of *Podocnemis erythrocephala* (Spix 1824, GÖLDI 1886b).

Göldi's experience in the study of plant-animal relationships, with six works published by 1886, was duly exploited by Brazilian periodicals and agricultural institutions. He became a regular contributor to the «Jornal do Agricultor» and the «Revista Agrícola do Imperial Instituto Fluminense de Agricultura», in which he published articles and annotated translations on harmful insects, pests and new cultivars. He also received a major task from the Imperial government: to study a disease that had been destroying coffee plantations in Rio for twenty years and to suggest ways of countering it. Göldi spent over a year on that study and drafted a detailed report, in which he described the disease, the more heavily infested places and its causal agent, a nematode (Fadenwurm) he named *Meloidogyne exigua* (Figure 4). This can be regarded as Göldi's most important research at the National Museum, as coffee was Brazil's top export product and also because of its international impact in the academic and agricultural milieu (GÖLDI 1888, 1889a, 1892, 1894a). Part of this impact was due to his description of the various stages of infestation and his

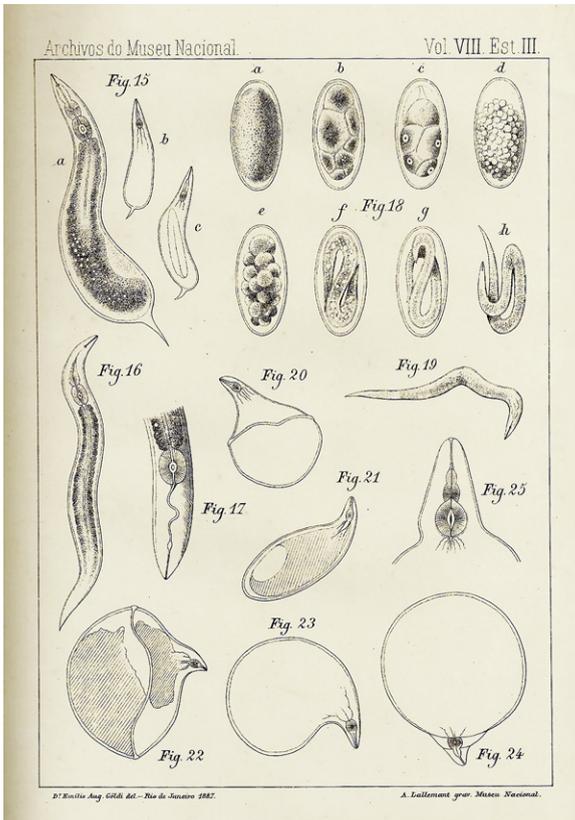


Figure 4: Third plate of Göldi's classic report (1892) on the coffee rootknot nematode *Meloidogyne exigua*, described by him in Rio de Janeiro.

suggestions for pest eradication. The worm discovered by Göldi would later be recognised as widely distributed in South and Central America and parasitic upon many other species. It came to be considered one of the main agricultural pests in the countries of that region.

In 1888 he was given a new task by the government, this time in São Paulo, where vineyards had been attacked by the grape phylloxera (Reblaus). After a few field trips, a report and a book entitled «Videiras americanas» («American grapevines») were published (GÖLDI 1889b, 1890). There he condensed the results of his research, gathered translations on the subject, described the natural history of the insect and also the international conventions for its control. The United States were identified as the place of origin of the grape phylloxera: there, the grapevines were shown to be more resistant to the pest, so one of the solutions proposed by Göldi was to graft (aufpfropfen) the plants recently coming from Europe on rootstock of native North American vines. This method – grafting onto rootstock of resistant American vines (Unterlagsreben) – was developed around 1880 by Charles Valentine Riley (1843–1895) and introduced by Göldi in Brazil.

Despite the good resonance of his work, Göldi faced some serious disputes in the National Museum after the November 1889 *coup d'état* that ousted Emperor Pedro II and installed a federative republican system in Brazil. Internal strife in the museum for resources and space for collections, allied with the Jacobinism and xenophobia of the political groups that took power, seem to be at the root of Göldi's dismissal in 1890. It also happened to the other four foreign scientists working in the institution, including famed Darwinist Fritz Müller (1821–1897) (LOPES 1997).

Göldi's dismissal from the National Museum must have had a devastating effect on his life. On 21 May 1889, he had married Adeline Meyer (1869–1953), the daughter of a Swiss trader settled in Rio, Carl Eugen Meyer, and a Brazilian, Marcelina Pereira. On 22 March 1890, at the peak of the conflict and just before his dismissal, his first son Walther Eugen (1890–1960) was born. Now, with the responsibilities of a husband and father, the zoologist suddenly found himself unemployed and supported by his father-in-law.

Göldi coloniser

Meyer owned a 6 000-hectare property in Serra dos Órgãos, near Rio de Janeiro. In partnership with Göldi, he started a colonisation project that foresaw the settling of some hundreds of Swiss immigrants to work in fruit production, viticulture and farming. They both went back to Switzerland in July 1890 in order to purchase seeds and implements, to engage the first group of settlers and to promote the project in the local press.

The enterprise started under unlucky preconditions: Karl Paganini (1868–1890), a Swiss engineer in agronomy hired to manage the project, died shortly before his departure in an accident during a mountain hike (AERNI 1992). In consequence,

Göldi himself had to take the lead. By March 1891, over a hundred persons had already arrived at the so-called «Colônia Alpina». However, that same year saw a series of conflicts within the Colônia, culminating in a revolt of the immigrants in mid-1892. The reasons for the riot were manifold. First the immigrants found awful housing conditions and a poor quality of food, furthermore the land tracts offered for planting were of minor quality and considered unsuitable because they were covered by forest. The Swiss Federal Government (Bundesrat) accepted the reported complaints and revoked the license Meyer had obtained to recruit settlers. The Bundesrat's decision took into account the fact that the settlers were poorly qualified and at odds with Göldi. The zoologist's conduct was regarded as inappropriate for keeping or renewing the confidence of dozens of families who suffered every kind of deprivation (*Figures 5 and 6*).

Göldi apparently did not spend much time in the administration of the Colônia or in listening to the complaints of the settlers. Instead, in the period he lived in Serra dos Órgãos, he carried out several research projects, increased his private collection (then with over 500 preserved animals) and installed a botanical garden and a weather station next to his home. The tension caused by the material deprivations gave Göldi the appearance of a «lunatic» to the settlers, like someone «mentally sick» with bizarre habits, such as taking long walks into the forest at



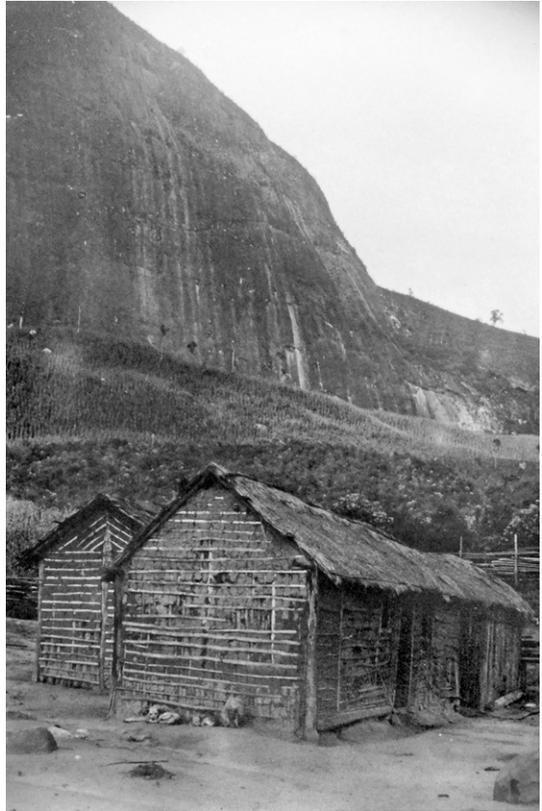
Figure 5: Eugen Meyer's house at the Colônia Alpina, Teresópolis, Brazil, in 1890. Unknown photographer. Photographic reproduction on paper. Stadtarchiv Schaffhausen, Switzerland, G 02.11.06/09.

Figure 6: Settlers homes at the Colônia Alpina, Teresópolis, Brazil, in 1890. Unknown photographer. Photographic reproduction on paper. Stadtarchiv Schaffhausen, Switzerland, G 02.11.06/09.

night in search of birds and rodents (Nagetiere) (SCHÄR 1892: 17–19).

For Göldi those birds, rodents and other animals certainly represented a link to his former scientific life and were the best remembrance of his stay in those mountains. They allowed him to keep in touch with many European scientists as well as to write some papers on the Mata Atlântica fauna³, still thriving there by the late 19th century. Thanks to his exchanges with Eugen von Keyserling (1833–1889) for instance, no less than 165 new species of spiders were described for the Tropics. Specimens were sent to St. Gallen, Schaffhausen, Zürich and London – the latter destination for the first time in Göldi's career. From Colônia Alpina, the zoologist began a productive exchange with the Zoological Society of London and the British Ornithologists' Union.

It was also at Colônia Alpina that Göldi concluded two books that would later open new pathways in his life: «Os Mammíferos do Brasil» («The Mammals of Brazil»), published in 1893, and «As Aves do Brasil» («The Birds of Brazil»), published in 1894. Despite being written in non-academic language, they are both regarded as classics of South American zoological literature for their compilation of an unprecedented synthesis of the species that occur in Brazilian territory, of their geographical distribution and of their biology.



³ Mata Atlântica (Atlantic Forest) is one of the existing biomes in Brazil, like the Amazonian Forest. It extended from the south to the northeast along the coast. This biome is best known for its biodiversity and the therein endemic species. It currently holds only 8% of the area it occupied 300 years ago, in small fragments threatened by urbanization, agricultural and lumber exploitation.

In October 1893, as he became acquainted with his book on mammals, Lauro Sodré (1858–1944), governor of the State of Pará, began negotiations in order to hire Göldi as the director of the Museu Paraense (Pará State Museum), founded in 1866 but almost neglected since. In January of the following year, a deal was signed and announced by SODRÉ (1894: 26) in his message to the State Congress in April, where he refers to Göldi as a «naturalist well respected for his works and his services to our country».

For Göldi the proposal from the governor of Pará came in good time, as it could well mean the restoration of his financial autonomy, the opening of a new institutional venue for his work and the strengthening of his scientific ties with Europe. These overall conditions seemed indeed advantageous because of his keen interest in the Amazonian forest.

The Amazonian adventure

Göldi arrived in the state capital Belém in June 1894. For over three decades, the city had been enjoying a period of prosperity, due to the exports of natural rubber (Kautschuk), extracted from a tree native to Brazilian Amazonia, *Hevea brasiliensis* (Figures 7 and 8). Rubber was at that time one of the primary raw materials for European and North American industries. Its uses were steadily increasing, e.g. in clothing, instruments and equipment making, automobiles, bicycles, etc.

Amazonia had become its largest world producer and Belém, as the main port in the region, benefitted from the construction of urban infrastructure and the installation of public services (Figure 9). One of the institutions considered a priority for the republican government of Pará was the Museu Paraense, now part of a project for the modernisation of the city (Figure 10). Thus Göldi's mission was to provide a new organisation for the museum and to develop it as an instrument for education and civilisation of the inhabitants as well as for the state propaganda. For these purposes, he could count on the unflinching endorsement of local authorities.

Four departments were created in the museum: Zoology with Comparative Anatomy and Embryology; Botany; Geology, Palaeontology and Mineralogy; Ethnology, Archaeology and Anthropology. All of these are still active today. Each of the departments would maintain scientifically classified collections and have its own body of researchers and technicians. A library, a photographic laboratory, taxidermy and herborisation workshops and a printing office were installed to support the scientific activities. Special attention was given to exhibitions, public lectures and publications – particularly to the «Boletim do Museu Paraense de História

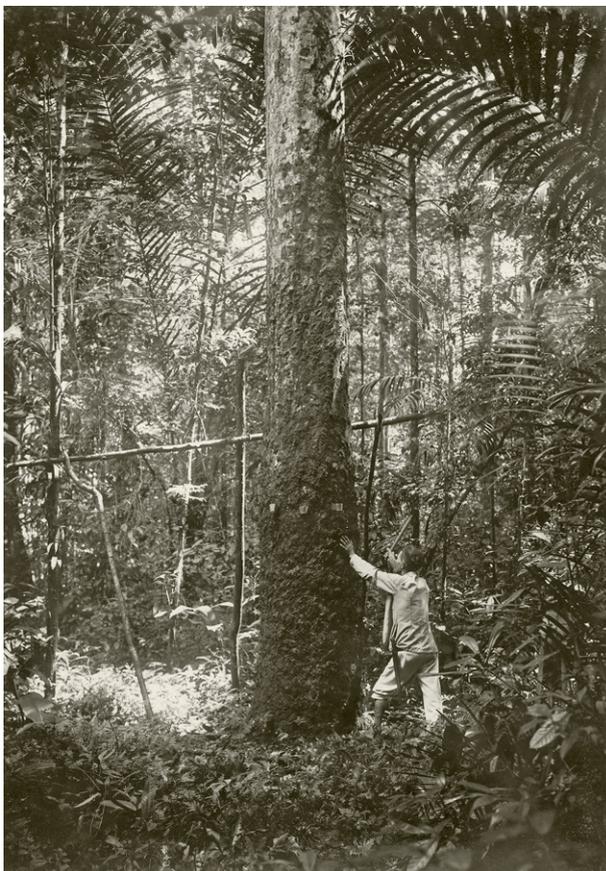


Figure 7: Rubber tapping in Purus River, Brazil, around 1903. Unknown photographer. Photographic reproduction on paper. Photographic Collection, Goeldi Museum, Belém, Brazil.



Figure 8: Rubber «balls» ready for export in Cobija, Upper Acre River, Bolivia, January 11, 1912. Photograph by Ernst Ule. Photographic reproduction on paper. Photographic Collection, Goeldi Museum, Belém, Brazil.



Figure 9: The port of Belém, capital of the State of Pará, around 1900. Post card. Private collection.



Figure 10: The Goeldi Museum main building in 1899. Unknown photographer. Photographic reproduction on paper. Staatsarchiv Basel-Stadt, Switzerland, PA 694c A 4–3 (1) 2.

Natural e Ethnographia» (Bulletin of the Pará State Museum of Natural History and Ethnography), whose first issue came out still in 1894. A small zoo and a botanical garden were also built and soon became the main tourist attraction and leisure area of Belém (*Figures 11 and 12*). In 1895 about 40 000 visitors were recorded. By 1900 they had surpassed 90 000 and in 1907 they reached 124 000, a number that represents over 80% of the city population at the time.

Figure 11: The Goeldi Museum zoo around 1900. The three daughters of Göldi, Cornelia (1891–1975), Leonie (1892–1965) and Mathilde (1894–1983), are pictured in this photo. Unknown photographer. Glass plate negative. Photographic Collection, Goeldi Museum, Belém, Brazil.

Figure 12: The Goeldi Museum botanic garden around 1902. The Austrian zoologist (and later botanist) Adolph Ducke (1876–1959) is pictured in this photo. Unknown photographer. Glass plate negative. Photographic Collection, Goeldi Museum, Belém, Brazil.



From the scientific standpoint, a regional research agenda was structured, concentrating on faunal and floral inventories, combining the compilation and revision of literature data with specimen collection, observation and experimentation. This Amazonian regional agenda would in fact distinguish the new Museu Paraense from other large museums and give it a special place in the international scientific arena. The implementation of this agenda included a program of collecting expeditions to several points in Amazonia, from the Atlantic coast to the Upper Amazon. Procedures for collecting, preparation, packaging and shipping animal, plant and geological samples were published and widely publicised. The result was an exponential increase of the collection holdings in the museum, from a few paltry dozen specimens in 1893 to many thousands a few years later. The best example of this growth in numbers is the bird collection, which held only 53 specimens when Göldi took office and expanded to over five thousand by the time he left the museum in 1907. By 1914 the ornithological collection of the Museu Paraense contained over 10 000 specimens and was the largest in the world in terms of Amazonian birds and among the richest in Neotropical avifauna (*Figure 13*).

This work pattern was maintained thanks to Göldi's exchanges with other institutions in Europe and North America and also thanks to a team of qualified and productive scientists. Göldi selected this team from his own circle of personal and academic acquaintances in Switzerland, Germany and Austria, demanding from the candidates a postgraduate degree in natural sciences and full-time dedication to the museum. For over thirty years, these requirements made the Museu Paraense a research centre with strong ties to universities, museums and botanical gardens of Central Europe. Some examples of researchers appointed by Göldi are: Austrian geologist Friedrich Katzer (1861–1925), Swiss botanist Jacques Huber (1867–1914), German zoologist Hermann Meerwarth (1870–1943), Swiss zoologist Gottfried Hagmann (1874–1946), Austrian zoologist Adolph Ducke (1876–1959) – who would also distinguish himself as a botanist – and German zoologist Emilie Snethlage (1868–1929), the first female scientist hired by a Brazilian institution in 1905.

Göldi diplomat

Besides his obvious scientific leadership, Göldi's political skills made him an important collaborator of the Brazilian government in the so-called Franco-Brazilian Territorial Dispute or the «Amapá Affair» (1895–1900). A large area located between the rivers Oyapock and Araguari, in the mouth of the Amazon and extending westwards over the plateau onto the banks of the Rio Branco, had been a stage for armed clashes and diplomatic incidents since the 17th century. France and Portugal and later Brazil continuously claimed their rights on this lesser known region in Amazonia, which was inhabited by several belligerent peoples. While the rough terrain and thick forest discouraged explorers, it inspired many fantastic

stories like those written by Walter Raleigh (ca. 1554–1618) and Jules Verne (1828–1905). In the 1890s, tensions in the region increased after the finding of a gold vein in the Tumucumaque mountain range and the intensification of illegal trade through the shifting borders between Brazil and French Guiana. In May 1895, the massacre of dozens of Brazilians by French soldiers outraged Europe and forced both involved countries to sign a Treaty of Arbitration. The President of the Swiss Confederation acted as the arbitrator for this territorial dispute – according to Göldi's suggestion to the Brazilian government (*Figure 14*) (TRATADO DE ARBITRAMENTO 1897).

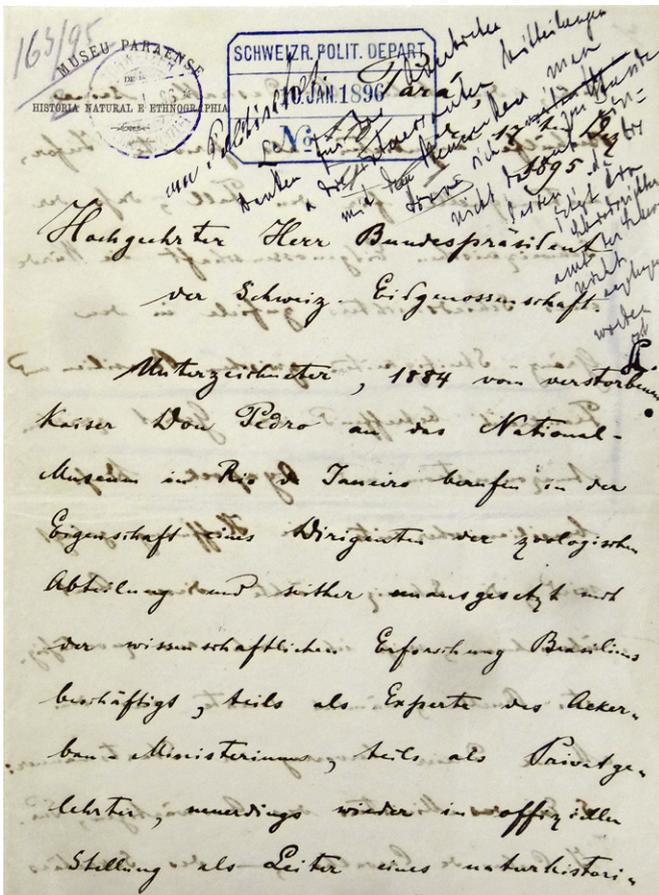


Figure 14: First page of Göldi's letter to the President of the Swiss Confederation (Bundespräsident der Schweizerischen Eidgenossenschaft) reporting his work at the Museu Paraense and the conflict between Brazil and France, Belém, December 17, 1895. In this letter Göldi asks the President if he is interested in arbitrating the conflict and states that this idea would be well accepted by the Brazilian government. Schweizerisches Bundesarchiv, Bern, Switzerland, E 2001 A 1000/45 BD:60.

Göldi took an active role in the efforts made by Brazilian diplomats, led by José Maria da Silva Paranhos, Baron of Rio Branco (1845–1912), to gather documentation and information that could prove the Portuguese – and later Brazilian – possession of the territory in question. In October and November 1895, Göldi himself went to the area of conflict, together with other Museu Paraense staff (*Figure 15*). He contoured the north Amapá coastline and entered the main rivers, where he collected specimens and archaeological objects. Furthermore he interviewed the survivors of the massacre, mapped the region and made a photographic survey of its inhabitants, villages and landscape. Göldi wrote two classified reports with strategic information for the Brazilian diplomatic corps. These reports included data such as the number of inhabitants, information on trade, the currency used, the language spoken, the sanitary condition of the villages and the



Figure 15: The members of the Museu Paraense expedition to the Amapá coast in 1895, after the massacre of Brazilians by French soldiers: from left to right, not identified employee, Swiss botanist Jacques Huber, Brazilian explorer and lieutenant colonel Aureliano Pinto de Lima Guedes, Manuel de Lima Guedes (Aureliano's son and apprentice in botany), Emil Göldi and Swiss taxidermist Max Tanner (standing behind). Note some archaeological urns on the floor, excavated in Cunani River and nowadays the main reference for the Cunani extinct indigenous people. Unknown photographer. Photographic reproduction on paper. Arquivo Histórico do Itamaraty, Private Papers of Baron of Rio Branco (Amapá Affair), Rio de Janeiro, Brazil.

main diseases in the region. In addition they contained suggestions for the political administration of the area.

Between 1896 and 1900, twelve articles on the disputed territory were published by Museu Paraense researchers, six of them written by Göldi himself. In all of them French documents and sources were discredited and their territorial intentions derided as imperialistic and unfair. This large corpus of knowledge put together in travel reports and in botanical, zoological, geological, archaeological and ethnographic studies, allowed the Brazilian government to challenge the French claims on «scientific» grounds. This political strategy designed the Brazilian territorial demands as «objective» and «neutral», in contrast to the French «imperialistic» position.

The dispute also motivated Göldi to make a long trip to Switzerland just before the President of the Swiss Confederation would render his decision. There he visited universities and museums, delivered lectures in scientific societies and published popular articles on the territory under dispute. The officially announced purpose of the trip was to promote the activities of the Museu Paraense, but in fact Göldi was in the service of the Baron of Rio Branco and had a very specific task to fulfil: to try to influence in Brazil's favour the four main expert advisors of the President of the Swiss Confederation on the territorial issue. Göldi not only socialised with all four but also became something of an *ad hoc* consultant for the Swiss government and a credible witness on the matter. That is how his name is mentioned in the decision of the Swiss arbitrator, published in December 1900 and favourable to Brazil.

In recognition of Göldi's «valuable contribution for the study and enlightening of our rights in the issue of our border with French Guiana», the government renamed the Museu Paraense as Museu Goeldi (Decree n. 933, 31 December 1900). In the early years of the 20th century, after a *tour de force* that took two years of his life, Göldi could finally accelerate the expansion of the museum, making plans for the construction of a great building for exhibitions and collections.

However, by 1904 a reorganisation of the political forces in the government and first signs of an approaching economic crisis postponed those plans and generated friction between Göldi and the governor. Reasons for this discord are not clear but certainly led to Göldi's demission, made official in March 1907. Since 1905 he was in fact trying to ensure the continuity of governmental support for the museum, whilst at the same time, he had sent away his family to Bern, anticipating the possibility of returning to Switzerland. In his letter of resignation, Göldi claimed to be in poor health and in need of personally supervising the education of his seven children, one of them with a serious cerebral condition.

Back to Bern

On 22 March 1907, Göldi left definitively for Europe, having spent just over 22 years in Brazil. As he arrived in Bern, he asked for the *venia legendi* (as private lecturer) in order to teach biogeography at the local university. Although he was approved with very high praise, Göldi's insertion in the Bernese scientific milieu was not easy in the first few years. Only in November 1908 did the university grant him the title of an «Extraordinary Professor», however without a salary. He faced the same kind of difficulty at the Natural History Museum Bern, where his friend and head of the Zoology Department, Theophil Studer (1845–1922), proposed his nomination as honorary member of the Board of Directors, a motion denied in the same year (MORGENTHALER 1993).

Göldi's luck began to change in May 1909 when he was chosen for the vice-presidency of the Society of Natural Science of Bern. In April 1910, he was elected president of the same society; only a few months before the Bernese Entomological Society (Bernische Entomologische Gesellschaft) had conferred their presidency on him (HUBER 2008). In November, when asking once again for a salary at the University of Bern, the Department of Education finally approved his request. By late 1911, following the vacancy of a chair, he was elected to the Board of Directors of the Natural History Museum Bern. His nomination was in recognition for the collections he had sent there since 1898 from Amazonia, first as «duplicates» of the Museu Paraense holdings, and later his personal collection from Rio de Janeiro as a donation (MORGENTHALER 1993; GÜNTERT ET AL. 1993; GÜNTERT ET AL. 2005; OBRECHT AND HUBER 1993).

In Bern Göldi was also strongly involved with Freemasonry, conservationism, and political activism in favour of human rights. In 1910 he was accepted as a «Brother» in the Masonic Lodge «Zur Hoffnung», where he began as a «Visiting Brother» and progressed towards higher echelons. In the following year, he gave two lectures at the Lodge, respectively entitled «A view on Monism» and «Natural Sciences – Cosmovision – Freemasonry». They both reveal a mystical scientist, as many of his generation were, and allow a glimpse into holistic philosophies that possibly have influenced his scientific oeuvre. Monism regards reality or the universe as a single domain – that of the substance formed by the indissolubility of matter and energy. It fits well with some scientific ideas discussed at the time, such as the claim for a single origin for all beings, like a permanent and infinitely fertile primordial entity (McCORMICK 1991).

In the case of conservationism, Göldi had shown his sensibility towards such concerns (very close to monism) since his days in Rio de Janeiro, when he had defended the ban on turtle hunting. In «As Aves do Brazil» he had protested against the catching of hummingbirds in Bahia for export (GÖLDI 1894b). In Belém he had proposed a total ban on hunting herons and scarlet ibises between June and January, the nesting period of those birds. Furthermore he had voted for public protection of bird flocks and for increasing taxes on exports of their feathers

(GÖLDI 1897a, 1902a, 1905a). According to Göldi, herons had their «natural rights» as they inhabited the Amazonian region since «time immemorial»; for this reason it was unfair that «hundreds of thousands of herons» died every year «so they could adorn the hats of ladies in the United States and in France» (GÖLDI 1897a: 29). That «execrable destruction» was for him «an unwarranted intrusion into, and an injury of, the cosmic order» (GÖLDI 1897a: 37).

In Switzerland Göldi resumed more actively his campaign for the protection of birds. In 1909 he was one of the founding members of the Swiss Society for Ornithology and Bird Protection (Schweizerische Gesellschaft für Vogelkunde und Vogelschutz, today named «Ala»), where he continued the fight against feather trade (HESS 1917). In 1913 he took part in the International Conference for the Protection of Nature in Bern; in the following year, during the Swiss National Exhibition of 1914, he published in «Der Bund» (the main newspaper of Bern) an impassionate protest entitled «Fort mit der Reiherfeder vom Damenhut!» («Down with the heron feathers on ladies' hats!») (GÖLDI 1914a). Finally, in the preface of his tome on the Swiss fauna «Die Tierwelt der Schweiz in der Gegenwart und in der Vergangenheit» («The fauna of Switzerland in the present and in the past»), he stated that the book was also aimed at «awakening the feeling that it is about time we look for effective measures in defense of the preservation of the national fauna, so threatened from all sides» (GÖLDI 1914b:5).

By 1915 Göldi raised another political flag. In the midst of the First World War, he signed a petition that was sent to the Federal Council, so that Switzerland would take the initiative to create a neutral international league for the defense of human rights. According to MORGENTHAUER (1993:193), this text «shows the author's moral and religious inclinations, but also his scientific and critical attitude». It seems to confirm, therefore, that his scientific oeuvre, his political activism for the conservation of fauna and for human rights, as well as his involvement in Freemasonry share interrelationships that often intertwine along Göldi's life. Those different aspects of his personality are part of a single array that, the more one studies it, the richer and more fertile it reveals itself to be.

Göldi's intellectual commitments

Göldi's oeuvre is unique above all because he overcame geographical, theoretical and chronological boundaries. Boundaries between Europe and Brazil, between «pure» and «applied» sciences, between science and popularisation of science and between 19th century and 20th century scientific traditions. This is not a feature exclusive to Göldi but it seems to be characteristic for him since his early studies. In Schaffhausen for instance, Göldi produced a consistent oeuvre in the field of agricultural zoology, by associating traditional practices, such as taxonomic research, with more recent biological and ecological knowledge. To a certain extent he replicated that approach in Rio de Janeiro, even though motivated by other



Figure 16: Plate 27 of the «Album de Aves Amazônicas» (GÖLDI 1906c), where the German painter and lithographer Ernst Lohse (1873–1930) pictured two species described by Göldi: *Pipra caelesti-pileata* (bird with the blue head in the centre of the plate) and *Galbalcyrhynchus purusianus* (brownish birds on top right of the plate). Scanning from the original watercolour preserved in the Naturhistorisches Museum der Burgergemeinde Bern, Switzerland.

socioeconomic problems and within a different physical environment. Both experiences reflect the changes that happened in the framework of scientific investigation, related to the dissolution of boundaries between science and technological development and between disciplines that apparently had little to do with one another. This «new science» that switched between practical local problems and theoretical questions of universal scope began to emerge by the mid-19th century, mainly in Germany (NYHART 1996, 1998).

In the Museu Paraense we find other examples of Göldi's ability of connecting knowledge. When Göldi began publishing faunal and floral inventories in the «Boletim do Museu Paraense de História Natural e Ethnographia», written by in-house and foreign researchers such as Alfred Wallace (1823–1913), Erich Wasmann (1859–1931), August Forel (1848–1931), Michael Oldfield Thomas (1858–1929) and Theophil Studer (1845–1922), he maintained at the same time an extensive contact-network for the identification of animals collected in Amazonia. This demanded the continuous remittance of specimens to several institutions in different countries, resulting in the description of 86 new species between 1894 and 1904, excluding those described by the museum's own staff. The scientists who described Amazonian species without ever having stepped into the region themselves, were among the most illustrious at the time, such as George Boulenger (1858–1937), Frederic Theobald (1868–1930), Édouard Trouessart (1842–1927) and Theodore Cockerell (1866–1948). If we added to the Amazonian remittances those of animals and plants from the Mata Atlântica that Göldi collected, bought or received as donation, we would have additional 233 new Brazilian species (GÖLDI, 1899a, 1899b, 1900a, 1901a, 1901b, 1902c, 1902d, 1904a).

Therefore, Göldi became a great supplier of tropical animals for scientists who could efficiently identify them, in contrast to the small number of species described by himself. In Rio de Janeiro the latter were only eight: in addition to the turtle and nematode already mentioned, two crustaceans (*Sylviocarcinus petropolitanus* and *Leptopodia lineata*), one lacebug (*Tingis formosa*) and three species of whiteflies (*Aleurodes goyabae*, *A. aepim* and *A. filicium*). In Belém he described thirteen species overall: two fishes (*Piratinga piraiba* and *Phreatobius cisternarum*), one weasel (*Putorius paraensis*), two birds (*Pipra caelesti-pileata* and *Galbalcyrrhynchus purusianus*) (Figure 16), three tamarin monkeys (*Midas imperator*, *M. thomasi* and *M. griseovortex*) (Figure 17), one frog (*Hyla resinifictrix*) and four midges (*Chironomus holoprasinus*, *C. calligraphus*, *Haematomyidium paraense* and *Simulium amazonicum*) (Figure 18). However, Göldi was clever in reversing for his own benefit a limitation imposed by the only incipient scientific collections and library of the Museu Paraense. As he was unable to describe each animal himself, he attached significance to his own position as the director of a museum located in Amazonia, by regularly supplying specimens for overseas museums and so obtaining credibility and prestige in the international scientific milieu.



Figure 17: Plate «Macacos novos e pouco conhecidos da região alto-amazonica (Rio Purús)» (New and poorly known monkeys from Upper Amazon region (Purus River)). Two of the three ape species described by Göldi are pictured (*Midas griseovortex* on top left and *M. imperator* on bottom right). The plate was designed by E. Lohse and was never published by Göldi. The original lithograph is preserved in the Goeldi Museum, Brazil.



Fig. 142. — Larva já crescida de *Chironomus calligraphus*, vista com fraco augmento. Pelo lado anal, face abdominal, apercebem-se uns saccos finos, transparentes, que têm a mesma função respiratoria, como os foliolos brancos da região anal das larvas dos Mosquitos typicos. A larva de *Chironomus*, n'esta phase de vida, já habita n'uma galeria protectora, por ella fabricada com fragmentos de algas, etc., e por isto de cor verde.



Fig. 141. — Cabeça da mesma larva, photographada com augmento mais forte. Vista ventral.



Fig. 140. — Joven larva, apenas sahida do ovo, de *Chironomus calligraphus*, photographada com augmento microscopico moderado. Nota-se na frente um par de pés, com ganchos curvos em roda; outro par encontra-se no ultimo segmento abdominal.



Fig. 139. — Certa porção de um d'estes cordões de *Chironomus*, vista com augmento microscopico mais forte. Os ovos no seu agrupamento natural mostram um colorido esverdeado devido ao seu conteúdo e acham-se já em adiantada phase de desenvolvimento, transparendo distinctamente a segmentação das larvas. Os ovos são acamados na massa gelatinosa e viscosa dos cordões, semelhantes em tudo aos que fabricam as fêmeas dos sapos (*Bufo*nides).



Fig. 138. — Trez cordões de ovos, na liberdade frescamente postos na superficie d'agua de um tanque por *Chironomus calligraphus*, mosquito não chupador de sangue e desprovido de proboscida propria para furar a pelle de outros animais. Vê-se o arranjo exquisto em linhas de zig-zag. Fraco augmento, vista photographica.



Fig. 144. — Vista photographica de uma aza do mesmo "*merum*", com ampliação ainda mais consideravel, para auxiliar o reconhecimento dos pormenores systematicos.

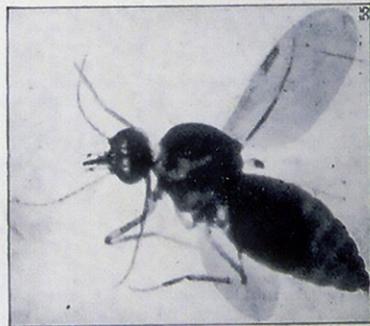


Fig. 143. — Vista photographica de um "*merum*", (*Haematomyidium paraense* G.) diminutissimo Diptero haematophago, assaz incomodativo na região amazonica, especialmente no littoral e na zona sujeita ás marés. Não é mosquito (*Culex*ido) propriamente dito, mas uma pequena mosca. Augmento microscopico assaz forte.

This procedure should be understood by taking into consideration the difficulties posed by Belém and Göldi's own agenda. For him it was important to involve the highest possible number of experts in animal identification and classification, but the description of a new species was only the first step of a zoologist's task. It would be more important to know the biological aspects of each animal, its geographical distribution and its habits – the kind of research only possible for someone in permanent contact with local nature. Göldi expressed that idea in numerous works, always mentioning that «the systematic denomination and diagnosis of a species is merely [sic] the gateway for entering the essential core knowledge of its life sphere – only a small fraction of the sum total of the natural history of the species» (GÖLDI 1905b: 169). So Göldi and his assistants dedicated themselves to writing up faunal inventories of almost all the great taxonomic groups of Amazonia. Furthermore they carried out and published biological studies of birds, mammals, reptiles, amphibians and arthropods. These articles had as their goal a compilation of reliable data for the organisation of a compendium on the fauna of Brazil, a sort of encyclopaedia that would be unprecedented in the zoological literature of that country – which Göldi, however, would never publish.

Across theoretical boundaries

Among the two hundred texts published by Göldi there are four sets that stand out because they testify the boundaries he crossed in his career: evolutionary studies, papers on medical entomology, anthropological articles and popular science publications. In the first group are the thesis he defended in Jena and the researches on two peculiar animals of the Amazonian region, the bird hoatzin (*Opisthocomus hoazin* Müller, 1776) and the South American lungfish (*Lepidosiren paradoxa* Fitzinger, 1837). The hoatzin possesses some unique anatomical characters that warrant its placement in the monotypical order Opisthocomiformes. In 1894 Göldi observed that young hoatzins have a pair of claws at the leading edge of their wings, which later become atrophied and disappear in adults. GÖLDI (1895a, 1895b, 1897b) regarded these claws as irrefutable evidence of «a very ancient inheritance of the early times of the independence, the individualisation of the class Aves from the common stem uniting birds and reptiles» (Figure 19). The claws would be, according to him, «a most interesting phylogenetic authentication, a new and unexpected touchstone for the truth of evolution and transformation» (GÖLDI 1895a: 173)⁴.

⁴ Göldi's insights were confirmed by recent researchers. Although the taxonomic and phylogenetic position of the hoatzin is not a consensus among ornithologists and paleontologists, the evolution of this bird is considered as an old and very special case. Hoatzin is currently well known from the anatomical, biological and behavioral standpoint. These studies reveal unique osteological and digestive systems in the class Aves (MARCELIANO 1996).



Opisthocomus cristatus.
(juv. et ova.)

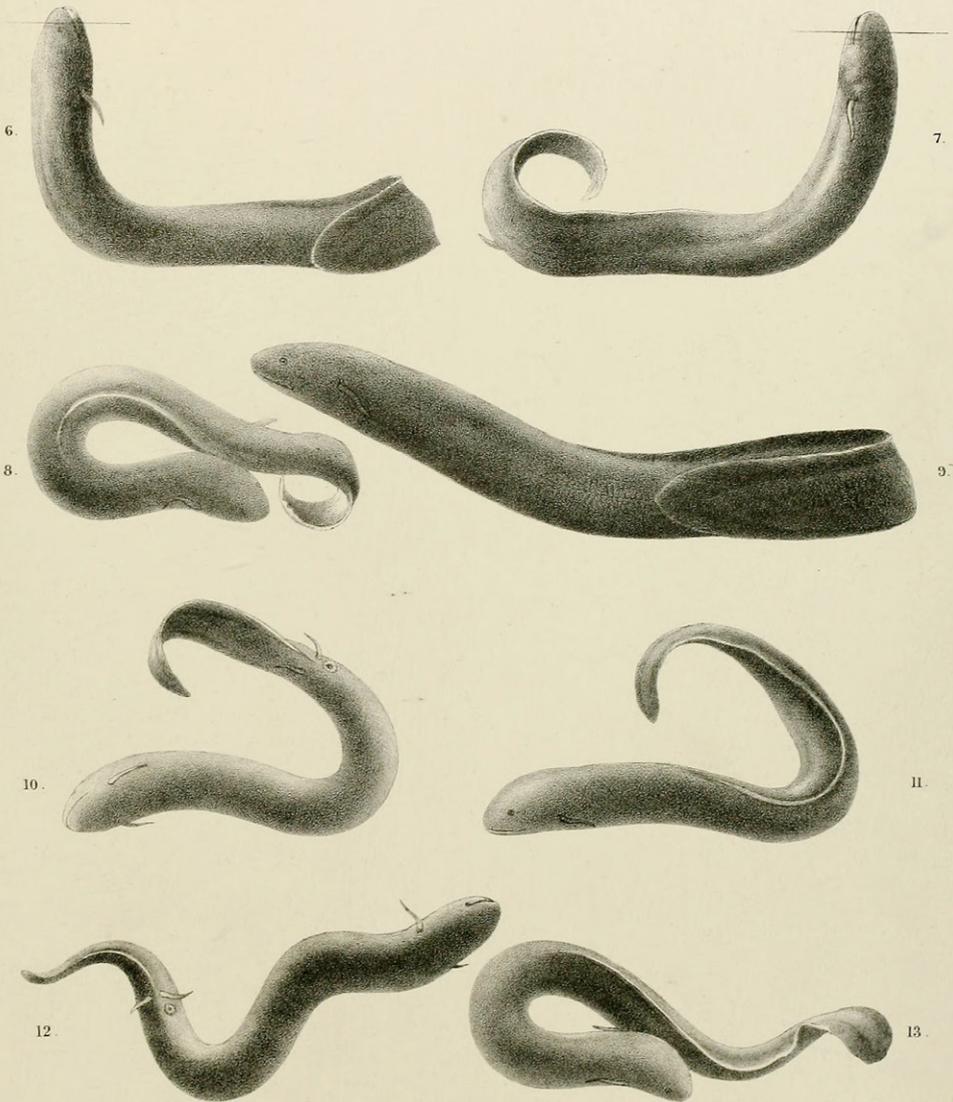
Figure 19: Illustration of hoatzin eggs and the pair of claws at the leading edge of the wings, published by GOLDI (1895a). Lithograph by Carl Wiegand, Belém, Brazil.

Göldi's Haeckelian background is evident in his attempt to relate individual development (ontogenesis) to the evolution of the species (phylogenesis), following the research agenda of the late 19th century in which phylogenetic reconstruction was a «passionate pursuit» (COLEMAN 1977: 85)⁵. In Belém Göldi remained active in that pursuit, observing the development of crocodile claws, the dispersal and distribution of the genus *Cervus* in South America and the reproduction among species of the genus *Cavia* (guinea pigs and cavies). The latter problem had been addressed by HAECKEL (1877: 131), in order to criticise the concept of species based on reproductive ability. However, among the animals he studied, the one that should have inspired Göldi the most from an evolutionary standpoint was the South American lungfish, obviously for the same reason the hoatzin had fascinated him: that fish species occupies an isolated position in the ichthyological classification by reason of its uncommon anatomy, which places it at the boundary between fishes and amphibians. Its skeleton is closer to that of a fish, but its circulatory and respiratory systems resemble those of an amphibian and include a pair of lungs (Figure 20).

Besides matters related to geographical distribution – as the one species occur in the Amazon, Paraguay and Paraná river basins – GÖLDI (1896, 1897c) pointed out *L. paradoxa* as one of the three extant lungfish species in the world (in Australia, Africa and South America) that are representatives of the group Dipnoi. The survival of those species in the Southern Hemisphere would constitute «unshakeable evidence and biological and zoogeographical authentication of an ancient distribution of seas and lands, different from the current one, and of a link between those continents in past geological periods» (GÖLDI 1897c: 250)⁶. Next he suggested that the explanation for the existence of lungs in the South American lungfish should be caused by the relationship between habitat and physiological function, especially regarding the aestivation period of the fish, which coincides with the drought in the rivers it inhabits (GÖLDI 1898a, 1898b). He points out that the lungfish is only able to survive such dry periods – when the floodplains give

⁵ The German biologist Ernst Haeckel (1834–1919) was one of the main promoters of the recapitulation theory, named by him as the Fundamental Biogenetic Law. This natural law was described for the first time in his 1866 «Prinzipien der Generellen Morphologie der Organismen». According to this law, the ontogenesis (or individual evolution during his life-time) is a short and quick recapitulation of phylogenesis (or group/species evolution during geological time) and this ontogenesis is carried out according to the laws of heredity and adaptation. Göldi studied with and assisted Haeckel at the University of Jena in 1881–1883. Other historians of science have appointed the influence of Haeckel upon Göldi's works, such as GLICK (2002) and GUALTIERI (2008). Both analyse Göldi's Amazonian works as important cases of reception and diffusion of evolutionary ideas in Latin America.

⁶ These thoughts put Göldi among the researchers who defended the existence of «links» or «bridges» between the continents such as Eduard Süess (1831–1914) and Hermann von Ihering (1850–1930). These theories of drifting continents would later be refined by Alfred Wegener (1880–1930), the founder of plate tectonics. Regarding the South American lungfish, Göldi's insights on its evolution and description of its life cycle are currently accepted (ARRATIA 2003).



P.J. Smit. lith.

EVOLUTIONS OF THE LIVING LEPIDOSIREN PARADOXA.

Mintern. Bros. amp

Figure 20: Plate «Evolutions of the living *Lepidosiren paradoxa* in a small aquarium (from instantaneous photographs taken by myself). Figs. 6 and 7 show the Dipnoan in the act of respiration on the surface», published in GÖLDI (1898a).

way to pastures – thanks to the pair of lungs it developed and to its ability to bury itself in the mud to keep its skin wet.

In Switzerland after 1907, Göldi dedicated himself to three major studies on the theme of descent (MORGENTHAUER 1993). The first one focused on social insects under two aspects: a) the «regulating law» that structures and organises life in society, above all among the ants; b) the definition of sex among honey bees, especially the way the Hymenoptera recognise and select fertilised eggs (which develop into queens and workers) from non-fertilised ones (which generate drones). On this subject Göldi developed a new theory, according to which this labour is performed by the worker bees, which separate the eggs and place them in their proper comb cells. By now it is known, however, that this issue is much more complex and not yet entirely clear, i.e., that the «sex ratio of bees is a subject that spans ecology and genetics, including kin selection, the mechanisms of sex determination, genetic load, and investment in reproductives» (ROUBIK 1992: 306; see also WINSTON 1987: 199–203).

The second study was about the phylogenetic development of insect heads and their mouth apparatus from crustaceans, an important concern at the time and still controversial today with respect to systematics. Here GÖLDI (1912b, 1913c) also suggested his own ideas, based on the homology of the mouth parts and taking into account physiological and biological factors to explain the morphological and anatomical differentiation between aquatic crustaceans and land insects (it should be noted that he had offered the same kind of argument to explain the uniqueness of the hoatzin and of the South American lungfish). So the mouth apparatus of insects would correspond to certain organs of crustaceans, which lost and changed their function when some of the latter group left behind their aquatic life (*Figure 21*)⁷.

Finally, his third study, developed in partnership with botanist Eduard Fischer (1861–1939), compares the evolutionary processes of sexual reproduction in the plant and animal kingdoms. It was initiated at the time of the 100th Meeting of the Swiss Society of Natural Science (Schweizerische Naturforschende Gesellschaft) in 1915, when Göldi presented a lecture on the theme. His goal was to establish, in the light of genetics, a theory and a nomenclature that could unify the studies on descent and transformation in the plant and animal kingdoms. He would certainly have proceeded on this theme, if he had not suffered a heart attack in the early morning of 5 July 1917 – at the young age of 57.

The second set of studies is geared towards a field that consolidated quickly in the late 19th century: medical entomology or the study of classification, biology

⁷ The derivation of the mouth apparatus of insects from legs of their crustacean relatives has been a hot issue for evolutionary researchers since the end of 19th century. Göldi's «new theory» is based on theoretical considerations on the transition from an aquatic to a terrestrial mode of life; however, it is not supported by current knowledge. Despite Willi Hennig's (1913–1976) extensive studies on this subject, the homology of insect mouthparts remains a matter of debate.

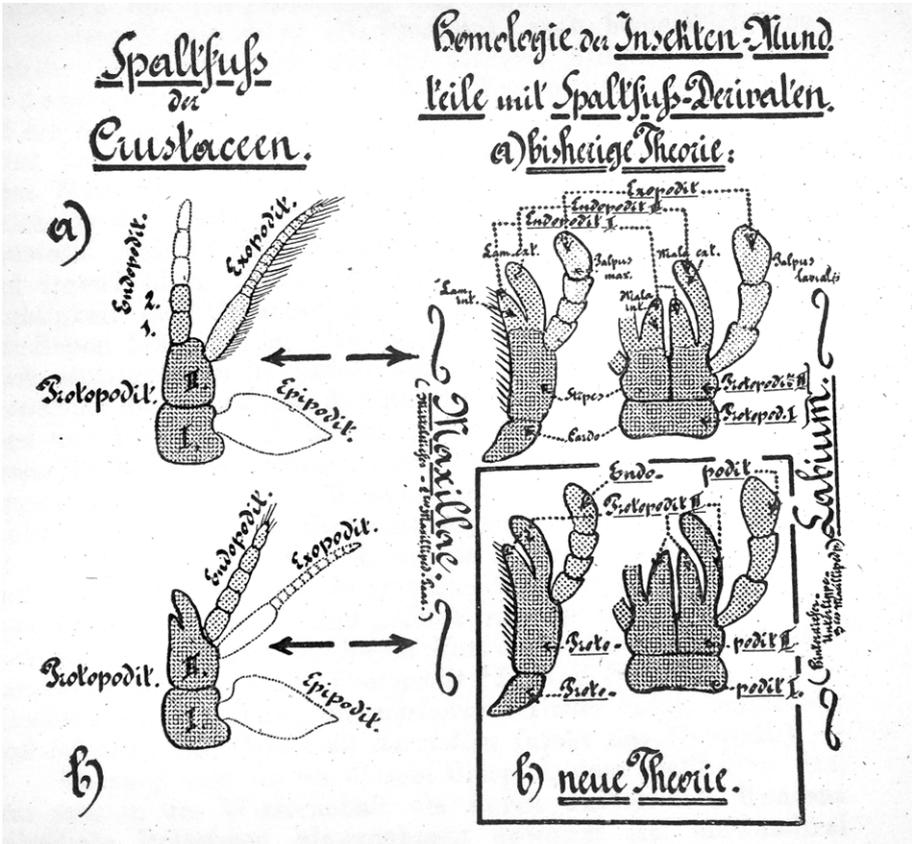


Figure 21: Göldi's drawing for his work on the homology of the mouth apparatus of crustaceans and insects. The «new theory» proposed by GÖLDI (1913c) is on the bottom right.

and ecology of insects that are harmful to humans and their role in the etiology of diseases such as malaria, filariasis and yellow fever (CHRISTOPHERS 1960; MATTINGLY 1969; HARRISON 1978; BENCHIMOL 1999). Göldi dedicated himself to little-known aspects of the classification, geographical distribution and biology of bloodsucking Amazonian mosquitoes, above all the Culicidae (Figure 22). His work was in the forefront of the concerns of medical doctors and zoologists after the confirmation of *Anopheles* in 1898 and *Aedes aegypti* in 1901 as the vectors for malaria and yellow fever, respectively (SANJAD 2003).

After inventorying the main Amazonian species of mosquitoes and describing their life cycles, Göldi made a number of suggestions to the health authorities; from the mandatory use of mosquito nets in private households to the organisa-

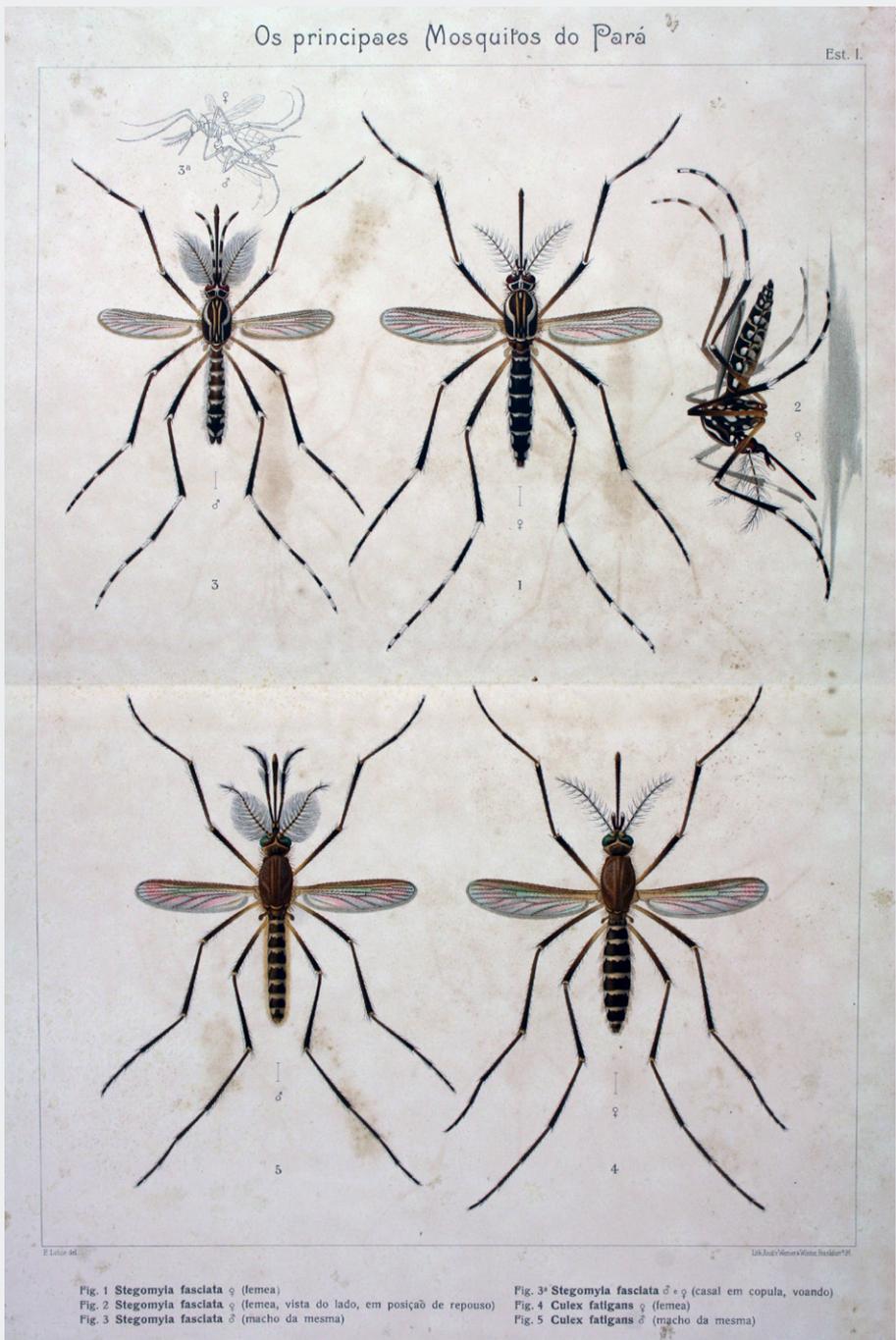


Fig. 1 *Stegomyia fasciata* ♀ (femea)

Fig. 2 *Stegomyia fasciata* ♀ (femea, vista do lado, em posição de repouso)

Fig. 3 *Stegomyia fasciata* ♂ (macho da mesma)

Fig. 3ª *Stegomyia fasciata* ♂ e ♀ (casal em copula, voando)

Fig. 4 *Culex fatigans* ♀ (femea)

Fig. 5 *Culex fatigans* ♂ (macho da mesma)

Figure 22: First plate of Göldi's work on the Amazonian mosquitoes, where the two main species from the health standpoint were painted by Ernst Lohse: *Stegomyia fasciata* (later renamed *Aedes aegypti*) and *Culex fatigans* (GÖLDI 1905c).

tion of «mosquito-brigades»⁸ (GÖLDI 1902b, 1902–1903). He performed a series of experiments with both species, manipulating hundreds of live specimens, and investigated the relationship between copulation and «haematophilia» in females and that between «haematophilia»⁹ and laying of fertile eggs. According to GÖLDI (1904b: 172), the first relationship could not be proven, but the second one was «essential». Those experiments were later expanded to other fourteen species of Diptera, with a detailed account of egg laying, the development of the larvae and the formation of pupae. Four new already mentioned species were described by Göldi, including the first description of a species of Simuliidae (black flies) in Brazil and a new genus of Ceratopogonidae (biting midges), both of great importance for public and animal health in Amazonia as vectors of filariasis and viral diseases (GÖLDI 1905c). The results were presented by Göldi at the International Congress of Zoology, in August 1904 in Bern, with his own theory on the controversial question of the infectious process of yellow fever: he proposed that the disease was not caused by a microorganism, as it would later be confirmed, but by an organic venom that would be inoculated by the mosquitoes (GÖLDI 1905d). Göldi would return to this subject, getting even closer to biomedicine, when he joined the University of Bern (GÖLDI 1913a, 1914c, 1918).

A third set of texts, less developed than the previous ones, deals with anthropological questions. Since his education in Switzerland, Göldi was attentive to the way different social groups relate to natural resources. Early examples are his publications on popular beliefs about animals and plants and on the history of flower cultivation. In Brazil the theme of the relationship between human culture and nature permeates many of his papers, as one can see in his writings on turtle hunting or on the Amazonian fish and bird fauna. Among the latter, he often stated that local myths and superstitions stimulated him to elucidate scientific issues and that he was often surprised by the knowledge of the local fauna shown by indigenous and riparian peoples, which allowed them to correctly identify animals and easily sorting them out by sex or age (GÖLDI 1897d, 1898c, 1901c, 1903). On the other hand, some few explicitly ethnological articles showed that Göldi was also keen on the study of material culture and on a compilation of data for a better arrangement of the linguistic stems of indigenous peoples, in a view akin to that of German ethnography (*Figure 23*) (GÖLDI 1898d, 1900b, 1906a, 1906b).

⁸ Among the prophylactic means against mosquitoes, Göldi endorsed the ideas of English, German and North-American scientists who worked in India, Africa and Cuba, respectively. Assisted by these scientists, the local governments organized several small groups of workers trained to eliminate larvae and adult mosquitoes in private households. These groups were known as «mosquito-brigades» or «mosquito-hunters».

⁹ The term means blood-feeding mosquitoes. Göldi compares these mosquitoes to vampires because the females must drink fresh blood before laying eggs. That is why he uses the term «haematophilia», usually associated to sexual fetishism for blood, «vampirism» or «vampire fetish». See SANJAD (2003).



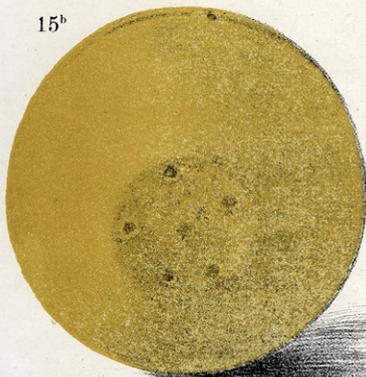
9



17

15^a

10

15^b18^b

lith. Museu Paraense
(E. Lohse)

phot. et dir. Dr. E. A. Goeldi

Cerâmica de Índios extintos no Counany (Guyana brasileira)

Figure 23: Second plate of Göldi's work on the material culture of Cunani Indians from the coast of Amapá, mouth of the Amazon River (GÖLDI 1900b). The urns were excavated by the Museu Paraense staff in 1895, photographed by Göldi and lithographed by Ernst Lohse.

His notes are sympathetic to the peoples who inhabited Amazonia before the arrival of the Europeans, saying that they are probably doomed to vanish, but from whom there was still much to be learned. For instance, after spending a week among the Temb  Indians, in the Capim River, G ldi wrote: «I will never forget this week among the Indians. It was a very instructive period for us regarding natural history and also ethnography and linguistics» (G LDI 1903: 486).

The last set of scientific texts was destined for a wider public, with an obvious didactic concern. In this way, G ldi joined a rationalist movement typical of the 19th century, in which scientists, teachers, journalists and commentators of diversified backgrounds had the goal to educate the population's views and thoughts, thus providing value to a field that was advancing prodigiously, that of science and technology. It was no coincidence that G ldi's earliest texts were published in popular periodicals and presented the vision of a scientist on common, non-scientific traditions. The same effort and desire to communicate with a wider audience would appear time and again in G ldi's life. So he had indeed two complementary and inseparable lines of activity in the scientific field, that of a researcher and that of an educator. His directorship at the Museu Paraense offered him many possibilities in this double field. For instance, his personal involvement in the construction of the zoological garden and in the setting up of exhibitions and public lectures, in addition to his many richly illustrated publications on the local fauna.

The same can be said of his activities in Switzerland after 1907, notably as a public speaker and a lecturer. At the University of Bern, G ldi lectured on animal biology and biology and selected for publishing the subjects he found «especially resonant among student circles» (G LDI 1913a: 5). Between 1911 and 1912, he gave in many towns of the canton of Bern the lecture «Aus der Heimat des Kautschuk und des Paragummi» («From the home of the caoutchouk and natural rubber»), by request of the alumni association (G LDI 1912a). According to MORGENTHALER (1993: 186), G ldi's concern in those lectures was above all «to present complex facts in the clearest way possible to his students, with unambiguous concepts and illustrative material» (*Figure 24*). The slides he used in his lectures were donated to the Natural History Museum Bern after his death. There are still over 450 of those slides (glass plates of 9 x 12cm), which show G ldi's particular care on being didactic. This concern is also reflected in the texts he wrote on the teaching of Zoology in Switzerland and in his intense activity in that country's scientific societies, particularly in the Society of Natural Science of Bern and Swiss Entomological Society (Schweizerische Entomologische Gesellschaft).

G ldi's oeuvre in Switzerland includes a smaller number of published works, in comparison to that in Brazil. However, those are denser texts, revealing the scientist's intellectual maturity. The subjects that most interested G ldi in that

period were evolutionary biology and medical zoology, but he addressed other areas that were important in his career, such as faunal studies. Examples of the latter include his paper on deer (GÖLDI 1913b), in which he described a new species from Argentina (*Odocoileus dickii*, currently synonym of *Ozotoceros bezoarticus* (Linnaeus, 1758)) and his catalogue of Swiss fauna (GÖLDI 1914b). According to LAENG (1973), Göldi's main contribution in the writings of this later period was in the field of biogeography, especially in passages where he discussed the origin and endemism of local species.

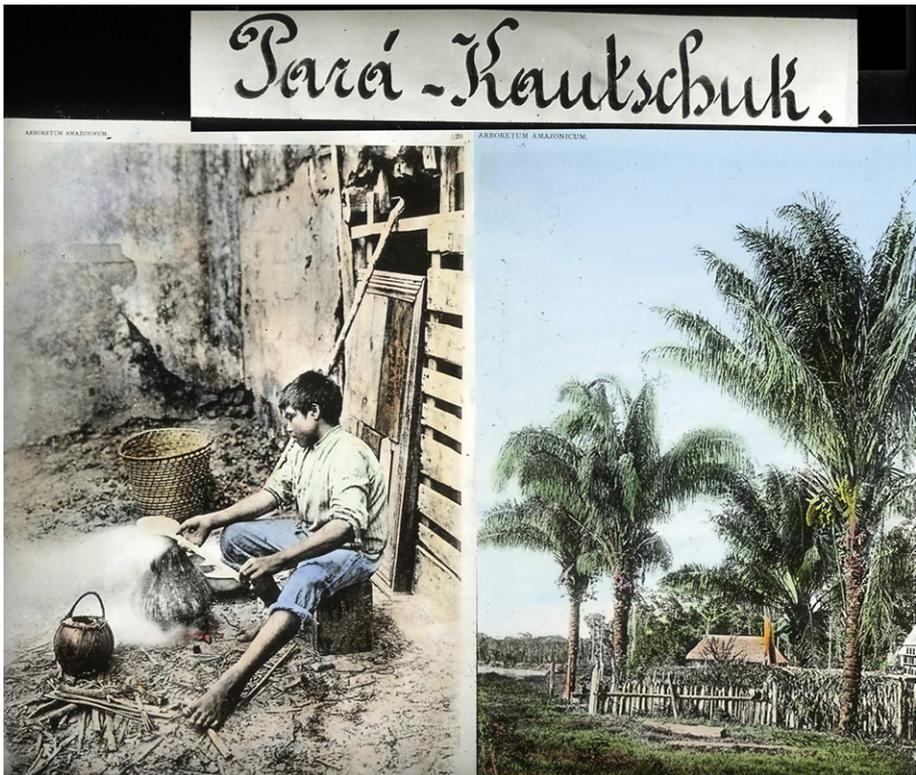


Figure 24: Hand-coloured glass plate negative used by Göldi in his lectures on the Amazon region, preserved in the Naturhistorisches Museum der Burgergemeinde Bern, Switzerland. Both photos were taken by Jacques Huber and published in the second (left) and fourth (right) issue of his «Arboretum Amazonicum» (HUBER 1900, 1906). These photos illustrate the fumigation (curing) process of natural rubber, in which the seeds of Urucuri palm tree (*Attalea excelsa* Mart. ex Spreng., right) are used for coagulation of the *Hevea* sap.

The Göldi collection at the Natural History Museum Bern (NMBE)

When the Natural History Museum Bern celebrated its 175th anniversary in 1982, Emil August Göldi was briefly mentioned in the «Festschrift» as a committee member from 1911–1917 and as donator of a scientifically important collection of Brazilian vertebrates (HUBER ET AL. 1982). Hardly any staff member knew more than this about Göldi's ties to the museum, and to the broad public, his name was at best known from a stuffed specimen of Goeldi's Marmoset (*Callimico goeldii* Thomas, 1904), which had formerly lived in the local zoo and was put on display in the gallery of mammals after its death.

Only in the course of compiling a digital inventory, started in 1988, the importance of Göldi's contribution to the collections at the NMBE became evident. The invertebrate part, mostly insects, exceeds the vertebrates by far – both by the number of individuals (*Figure 25*) and of type specimens. Of 118 new species names 102 refer to insect taxa (OBRECHT & HUBER 1993)¹⁰. These, however, had been described by the entomologist Adolph Ducke (1876–1959), and 80 years after their accession to the Bernese museum, the interrelation between Ducke's types and Emil Göldi had fallen into oblivion.

By pure coincidence, in 1989 three lines of evidence for Göldi's activities in Bern converged independently at the NMBE: Hans Ulrich Morgenthaler, a retired high school teacher, submitted a manuscript on Göldi's years in Bern and on his con-

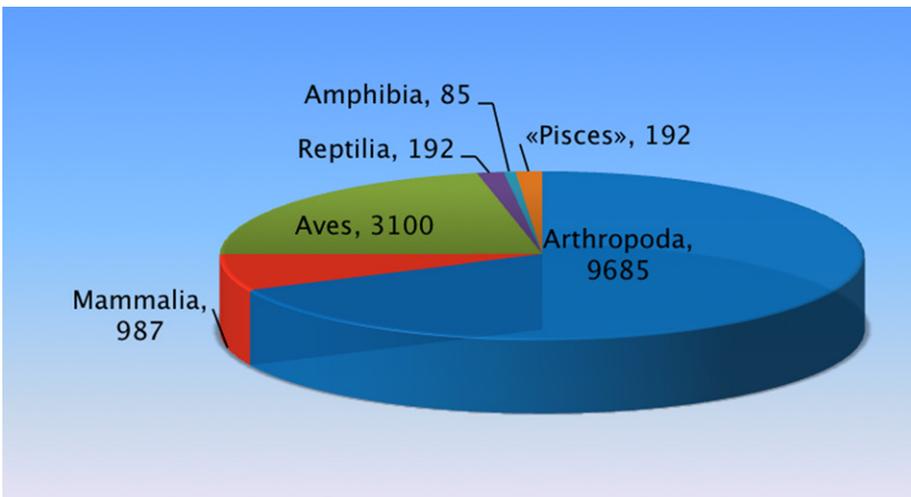


Figure 25: E.A. Göldi collection from Brazil, kept today at the NMBE: Number of specimens in different animal groups. Together with four mussel shells and 17 fossils the total number of specimens is 14 125.

¹⁰ http://www.nmbe.ch/sites/default/files/uploads/pubinv/ducke_types_specimens.pdf

Mollusca				4
Arachnida (spiders)				37
Insecta				9645
Lepidoptera		3855		
Coleoptera		3416		
Hymenoptera		1436		
Heteroptera		315		
Diptera		311		
Homoptera		144		
Saltatoria		104		
Odonata		45		
Blattodea		12		
Phasmodea		5		
Mantodea		2		
other insect groups		74		
Vertebrata				4420
	Private collection	MPEG deposit	Total	
Chondrichthyes	1	0	1	
Osteichthyes	97	94	191	
Amphibia	67	28	85	
Reptilia	96	96	192	
Aves	716	2248	2964	
Mammalia	196	791	987	

Table 1: Holdings of the NMBE Göldi collection from Brazil. All insect specimens seem to belong to the depository of the Museu Paraense Emilio Goeldi (MPEG). Göldi's private collection contains 1173 specimens, mostly from Colonia Alpina (Teresópolis) and few from Rio de Janeiro. Not included are 237 non-Brazilian bird skins that came from the Natural History Museum London (see GÜNTERT ET AL. 2005).

tributions to insect biology, for publication in the «Jahrbuch», then the triennial report of NMBE (MORGENTHALER 1993). His father, Otto Morgenthaler (1886–1973), had been a student of Göldi during his time at the University of Bern, and through him a number of notes and drawings relating to Göldi's lectures and publications had come into the son's possession.

At this time, an elderly couple, Werner Ruch-Beck and his wife, from Bienne, offered a large amount of documents (some 450 glass transparencies, letters and postcards) to the museum, because they planned to move to a smaller apartment. As stated by them, these documents had passed through Göldi's secretary to a relative of Mrs. Ruch-Beck. According to her, Göldi preferred to work at his sec-

retary's apartment during hot summer days – a cooler place than the university office. It can be assumed that these documents were left behind when the family returned to Brazil after their father's death. A special treasure among the glass transparencies is a series of pictures on rubber production in Brazil, together with the manuscript of Göldi's talk on this topic. The majority of the slides were obviously used during the university lectures; for the production of these slides he had repeatedly received payment from the department of education.

Driven by a keen interest in the fates of Swiss emigrants in South America and Eastern Europe Agathon Aerni (1929–2006), a retired banker, Consul General of Trinidad and Tobago and amateur historian contacted the NMBE with a request on collection items and documents related to Jacques Huber and Emil August Göldi. Aerni was investigating the biography and work of Jacques Huber, chief botanist at the Museu Goeldi and its director after 1907. After the publication of a short biography, he started – with unchanged zeal – digging into Göldi's past, unraveling the path of Göldi's life with his detours into agriculture and diplomacy.

Pointing out the importance of Göldi and Huber in the exploration of the Amazonian tropics, he suggested presenting an exhibition on their biographies and their lifework. For such a project the museum focused on the taxonomic and biogeographic aspects of the specimens. In this context an overview of the collection was published by the curators of the vertebrate and arthropod collections (GÜNTERT ET AL. 1993)¹¹. The biographic and historical background was worked up by Agathon Aerni. Very painstakingly he enquired into the biographies of persons in Göldi's surroundings – relatives, friends, scientists, employees and even the experts in the Amapá arbitration. His summarized notes, unfortunately without indication of the sources used, are kept in the NMBE archive.

The exhibition was shown to the public from October 1992 to 1993, together with an important part of the collection, which had never been on display before (Figure 26). Later in 1993, the exhibition was shown at the «Museum zu Allerheiligen» in Schaffhausen, though without the Bernese collection items.

Transfer and contents of the collection

Since his early times in South America, Göldi had sent specimens to his former teachers in Switzerland, intended for the natural history collections in St. Gallen and Schaffhausen. The motivation was to maintain good relations and to let people in his home country participate in his discoveries. Later he extended the circle of recipients to scientist friends or to experts on given taxonomic groups at other museums, among them the natural history museums in São Paulo, London and Vienna.

After having met Theophil Studer in Bern, Göldi dispatched a first shipment of mammal skins and turtles that arrived in Bern already in December 1898; others

¹¹ http://www.nmbe.ch/sites/default/files/uploads/vert/goeldi_collection.pdf



Figure 26: A part of the Göldi collection on display at the NMBE, during the exhibition «Emil August Göldi und Jacques Huber. Schweizer Naturforscher und Sammler in Brasilien». The weapons were loans from the Bernisches Historisches Museum (History Museum of Bern). Photograph: K. Grossenbacher, NMBE.

followed in 1899 and 1901. But things took another dimension when Göldi, in a letter of 20 June 1901 to Studer, proposed to deposit part of the Museu Goeldi collection in Bern, to keep it in a safe place away from the risks of the tropical climate. This was by no means just a courtesy to Studer, for Göldi still intended – and explicitly stated it in his letter of 15 April 1902 – to donate his private collection to the museum of his native canton St. Gallen (GÜNTERT ET AL. 1993: 150). Impatient as ever, Göldi did not wait for an answer: In the summer of the same year a first shipment of some 1500 lepidopterans – specimens particularly damageable by moisture or mould – was sent as a depository to Bern.

In November 1901 the Board of Directors (Museumskommission) discussed the idea of a depository and agreed to accept it, yet only under the condition that the loan had to be permanent and irrevocable. A contract based on this condition was set up, signed in 1903 by Göldi and by the Board. It was then referred for ratification to the Executive Council of the Burghers of Bern (Kleiner Burgerrat). The contract copy in Bern is signed from the Brazilian side only by Göldi, whereas the counterpart in Belém also bears seal and signature of the Governor of Pará (W. L. Overall, pers. comm.).

Details of the following shipments can be reconstructed from the notifying letters to Studer and the minutes of the Board of Directors (see list in GÜNTERT ET AL. 1993). In 1906 birds and deer antlers from the Organ Mountains, i.e. Göldi's

private collection, reached their destination at the NMBE; Göldi formally donated it to the museum in 1908. The depository in Bern was further enlarged after Göldi's return to Bern. These shipments contained mainly hymenopteran insects, among them numerous Ducke's type specimens, and were dispatched either by Göldi's successor Jacques Huber or the entomologist Adolf Ducke. The last shipments recorded in the NMBE archives arrived between 1909 and 1911.

All specimens of the Göldi collection at the NMBE have been digitally inventoried. The NMBE data register is not freely accessible via the internet; however, Excel lists of specified groups are available on request from the responsible departments.

Beyond Boundaries: Emil Göldi's legacy

Göldi skilfully managed to identify and join the debates around issues that were at the cutting edge of knowledge between the late 19th and early 20th centuries. Such issues were generally open to the participation of scientists of various backgrounds and different origins; they were at the boundary of science and technology or of various traditional scientific fields such as zoology and agronomy or zoology and medicine (interdisciplinary work in its best sense). They were also controversial and dynamic in the sense that ideas would quickly shift or new knowledge would be produced and disseminated.

Göldi's involvement in agricultural zoology or in medical entomology, exactly at the moment when studies within the framework of public health switched from the search for pathogens to that of disease vectors, is the most visible evidence of his awareness towards research opportunities. But it is not the only one. Even in a traditional scientific field such as taxonomy, regarded by many historians of science as outdated or secondary after the advent of the theory of evolution and of ecology by the late 19th century, Göldi managed to find some obscure spots and bring attention on them. As a result he established himself as an authority to occupy a prominent place in the international scientific milieu. It was precisely due to his taxonomic and biological work in Colônia Alpina and in the Museu Paraense that Göldi was admitted to the Zoological Society of London as a Corresponding Member in 1895 and to the select group of the Honorary Members of the British Ornithologists' Union in 1898 (SANJAD 2010b).

Göldi's international recognition was certainly due to his new position, the directorship of the first natural history museum located in Amazonia and of what he could represent for European institutions as a supplier of collections. However, the logic of the colonial relationships between «metropolis» and «periphery» does not explain everything. Since the 19th century, scientists established in the main European museums conceded they did not master all subjects in their respective fields, so they had to keep a set of correspondents in «peripheral» institutions and eventually involved them in research projects. That was the case of the Amazon-

ian bird fauna, the knowledge of which was regularly pointed out in scientific journals as being fragmented and inadequate at that time. Besides the fact that the taxonomic knowledge then available was a bone of contention, few scientists worked on the theme and even fewer did in loco research, which was a requirement for building up collections and obtaining biological and environmental data. To that situation, one should add the enormous scope of the work still to be done, already well discernible by the end of the 19th century, when all predictions on Neotropical biodiversity surpassed the wildest calculations.

Göldi had a clear perception of those aspects, that is of the advantages and disadvantages of being located on the sidelines of the European scientific circles. In order to accentuate the advantages, he gave priority to the collection of birds and mammals, thus starting the Museu Paraense collections, and to the exchange with foreign institutions. He filled his writings with criticisms towards travellers, with remarks on the colossal task of zoologists in Brazil and with descriptions of places hitherto unexplored by naturalists, of animals that were poorly described, rare, bizarre or little known. This editorial strategy lured the attention of both the lay public and the specialist in scientific matters. Göldi often studied the work of great scientists of that time, looking for doubts, flaws and gaps that could lead to new investigations, from which he would begin a dialogue with his overseas counterparts.

When he returned to Switzerland, he took along enough material to continue his research on the Amazonian fauna but did not devote much time on the subject: he merely gave some lectures on his stay in the «land of the rubber». Instead, he expanded his evolutionary and biological studies according to the more recent theories and techniques developed in the early 20th century in the fields of physiology and genetics. An overall view of Göldi's oeuvre demonstrates how it followed the course of the natural sciences in that period and how, at the same time, it oscillated according to the opportunities and circumstances that appeared throughout his life.

With respect to Brazil, the zoologist had the merit of initiating the research in several scientific areas and taxonomic groups. Furthermore, he also brought up to an unprecedented high level the workings of the institutional framework of science. These are planning institutional activities, formulating projects and agendas, encouraging exchanges, professionalising research by means of hiring post-graduate scientists, cultivating scientific culture through publications and exhibitions and promoting the popularisation of science as a necessary step towards scientific and social development. Those principles, that today form the unequivocal basis of scientific activity, were introduced in Brazil through great effort and some personal sacrifice by pioneers such as Göldi and became a fact in the institutions they created and worked at, such as the museum that today bears the zoologist's name – the second largest in the country. Those institutions are simultaneously the most significant legacy of these men and women and the living memory of their achievements.

Acknowledgments

The authors are in debt to Agathon Aerni (1929–2006), who gathered many data regarding Emil Göldi's life. Unfortunately his sparse notes were not published but could be consulted by the authors at the Naturhistorisches Museum der Burgergemeinde Bern (NMBE), Switzerland. The authors thank the Goeldi Museum (Belém), Naturhistorisches Museum Bern (Bern), Stadtarchiv Schaffhausen (Schaffhausen), Staatsarchiv Basel-Stadt (Basel), Schweizerisches Bundesarchiv (Bern) and Arquivo Histórico do Itamaraty (Rio de Janeiro) for the authorization to reproduce photographs, lithographs and paintings preserved in these institutions, and also its libraries and archives staff for their kind support; the Naturforschende Gesellschaft in Bern for its support; the editor, Dr. Thomas Burri, as well as Dr. Charles Huber and Elsa Obrecht (NMBE) for their review and comments on this article; and Dr. Horácio Higuchi (Goeldi Museum) for his comments and the translation of this article to English. NS was a Post-Doctoral Fellow of the Capes Foundation, from Brazil, at the NMBE (2013–2014). This article is part of a broader research on Swiss scientists who worked in the Amazon region in the 19th and early 20th centuries, also supported by the Emilie-Guggenheim-Schnurr Foundation, from Basel, Switzerland.

References

- AERNI, A. (1992). Der Naturforscher Prof. Emil August Göldi, 1859–1917. Teil 1–3. Werdenberger & Obertoggenburger. Der Alvier (Buchs SG). Nr. 202:7, Nr. 212: 7, Nr. 216:7.
- ARRATIA, G. (2003). Lepidosirenidae (Aestivating lungfishes). In: REIS, R.E. (Eds.). Checklist of the Fresh-water Fishes of South and Central America. Porto Alegre, EDI-PUCRS: 671–672.
- BÉNAT-TACHOT, L. & GRUZINSKI, S. (Eds.). (2001). Passeurs culturels. Mécanismes de métissage. Paris, FMSH Editions.
- BENCHIMOL, J.L. (1999). Dos micróbios aos mosquitos. Febre amarela e a revolução pasteuriana no Brasil. Rio de Janeiro, Editora Fiocruz/Editora UFRJ.
- BENCHIMOL, J.L. (2003). Adolpho Lutz: um estudo biográfico. História, Ciências, Saúde-Manguinhos, 10: 13–83.
- BENCHIMOL, J.L., SA, M.R., BECKER, J., GROSS, T., ANDRADE, M.M., FERREIRA JUNIOR, P.C.G., CRUZ, M.S.A., BULHÕES, T.S. & GOMES, V.L.C. (2003). Adolpho Lutz e a história da medicina tropical no Brasil. História, Ciências, Saúde-Manguinhos, 10: 287–409.
- COLEMAN, W. (1977). Biology in the Nineteenth Century: problems of form, function and transformation. Cambridge, Cambridge University Press.
- CHRISTOPHERS, S.R. (1960). *Aedes aegypti* (L.), the Yellow Fever Mosquito. Its Life History, Bionomics and Structure. Cambridge, Cambridge University Press.
- GLICK, T.F. (2002). On the Theory of Recapitulation in Brazil: Emilio Goeldi and Hoatzin Fledglings (*Filhotes da Cigana*). In: PUIG-SAMPER, M.A. et al. (Eds.). Evolucionismo y Cultura: Darwinismo en Europa e Iberoamérica. Madrid, Doce Calles: 391–395.
- GÖLDI, E.A. (1879). Verzeichniss der im Kanton Schaffhausen vorkommenden Vögel. Journal für Ornithologie, 27, 7: 357–385.
- GÖLDI, E.A. (1880a). Die Elster in Mythologie und Volksglauben. Vortrag, gehalten in der St. Gallischen Naturforschenden Gesellschaft, 31. August 1880. Neue Alpenpost, Zürich, v. 11.
- GÖLDI, E.A. (1880b). Rabe und Krähe in Mythologie und Volksglauben. Eine kulturhistorisch-naturwissenschaftliche Studie. Neue Alpenpost, Zürich, 12, 1: 5.
- GÖLDI, E.A. (1880c). Galileo Galilei. Neue Alpenpost, Zürich, 12, 2: 15–16; 3: 22–23; 4: 30; 5: 37–38; 6: 46; 7: 54; 8: 61–62; 9: 70; 10: 78.
- GÖLDI, E.A. (1880d). Ornithologische Beobachtungen am Bielersee während des Winters 1879–1880. Nach meinem naturwissenschaftlichen Tagebucke. Der Zoologische Garten, Frankfurt, Jahr 21: 213–217, 249–253.
- GÖLDI, E.A. (1881a). Ein zoologischer Streifzug im Golfe von Neapel. Daheim, Leipzig, 17, 25: 395–396.
- GÖLDI, E.A. (1881b). Ornithologisches aus Neapel. Journal für Ornithologie, 29, 9: 188–196.
- GÖLDI, E.A. (1884). Kopfskelett und Schultergürtel von *Loricaria cataphracta*, *Balistes capriscus* und *Accipenser ruthenus*. Vergleichend anatomisch und entwicklungsgeschichtliche Studien zur Deckknochenfrage. Inaugural-Dissertation. Jenaische Zeitschrift für Naturwissenschaft, 17: 1–46.
- GÖLDI, E.A. (1885). Studien über die Blutlaus (*Schizoneura lanigera* Hausmann). Mit 3 lithographischen Farbtafeln (Subventioniert durch Beschluss vom Regierungsrat des Kantons Schaffhausen am 31. Juli 1884). Schaffhausen, Verlag von Fr. Rothärmel.
- GÖLDI, E.A. (1886a). Bedeutung, Fang und Verwertung der Schildkröten am Amazonas (Portugiesisches Manuskript von Senhor João Martins da Silva Coutinho, frei übersetzt und mit Anmerkungen und Zusätzen versehen von Dr. Emil Göldi, Prof. der Zoologie in Rio de Janeiro). Der Zoologische Garten, 27: 329–335, 366–372.
- GÖLDI, E.A. (1886b). Über eine vermutlich neue Schildkröte der Gattung *Podocnemis* vom Rio Negro und über die Chelonier des Amazonas-Gebietes im Allgemeinen. Referat über ein portugiesisches Manuscript des Senhor João Martins da Silva Coutinho, betitelt «Sobre as Tartarugas do Amazonas», nebst Anmerkungen und Zusätzen. Bericht über Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft während des Vereinsjahres 1884/85: 273–280.

- GÖLDI, E.A. (1887). Aphorismen, neue Resultate und Conjecturen zur Frage nach den Fortpflanzungs-Verhältnissen der Phytophtiren enthaltend. Mitteilungen der Schweizerischen Entomologischen Gesellschaft, 7: 158–166.
- GÖLDI, E.A. (1888). Resumo do Relatório sobre a moléstia do cafeeiro na Província do Rio de Janeiro. Revista Agrícola do Imperial Instituto Fluminense de Agricultura, 19: 1–64.
- GÖLDI, E.A. (1889a). Der Kaffeenematode Brasiliens (*Meloidogyne exigua* G.). (Biologische Miscellen aus Brasilien VII). Zoologische Jahrbücher, 4: 262–267.
- GÖLDI, E.A. (1889b). Relatório provisório sobre a comissão relativa às moléstias da parreira na Província de São Paulo, principalmente quanto à questão phylloxerica. Revista Agrícola do Imperial Instituto Fluminense de Agricultura, 20: 59–76.
- GÖLDI, E.A. (1890). Videiras Americanas; collecção de trabalhos relativos à descripção e cultura das videiras norte-americanas, à história natural e distribuição do Phylloxera e às convenções internacionais anti-phylloxericas. 2 v. Rio de Janeiro, Typ. Universal Laemmert & Cia.
- GÖLDI, E.A. (1892). Relatório sobre a moléstia do cafeeiro na Província do Rio de Janeiro. Archivos do Museu Nacional, 8: 7–123.
- GÖLDI, E.A. (1893). Os Mammiferos do Brazil (Monographias Brasileiras I). Rio de Janeiro, Alves & Cia.
- GÖLDI, E.A. (1894a). Memoria sobre una enfermedad del Cafeto en la Provincia de Rio de Janeiro; por el Doctor Emilio A. Goeldi, traducido del portuguez y anotada por Gabriel Gomes, Ingeniero agrônomo. México, Offic. Tip. de la Secretaria de Fomento.
- GÖLDI, E.A. (1894b). As Aves do Brazil (Monographias Brasileiras II). Primeira Parte. Rio de Janeiro, Alves & Cia.
- GÖLDI, E.A. (1895a). *Opisthocomus cristatus*. A «Cigana»; resenha ornithologica. Boletim do Museu Paraense de História Natural e Ethnographia, 1: 167–184.
- GÖLDI, E.A. (1895b). *Opisthocomus cristatus* besitzt in seiner Jugend (und bloss dann) ein Krallenpaar an jedem Flügel. Ornithologische Monatsberichte, 3: 69–71.
- GÖLDI, E.A. (1896). *A Lepidosiren paradoxa*; descoberta na Ilha de Marajó. Boletim do Museu Paraense de História Natural e Ethnographia, 1: 438–443.
- GÖLDI, E.A. (1897a). Destruição das garças e guarás. Boletim do Museu Paraense de História Natural e Ethnographia, 2: 27–42.
- GÖLDI, E.A. (1897b). Das Schopfhuhn (*Opisthocomus cristatus*) «Cigana». Eine ornithologische Studie. Schweizerische Blätter für Ornithologie, 21.
- GÖLDI, E.A. (1897c). *Lepidosiren paradoxa*. Boletim do Museu Paraense de História Natural e Ethnographia, 2: 247–250.
- GÖLDI, E.A. (1897d). *Mesomys ecaudatus*; um roedor esquecido durante meio século. Boletim do Museu Paraense de História Natural e Ethnographia, 2: 253–255.
- GÖLDI, E.A. (1898a). On the *Lepidosiren* of the Amazons; being notes on five specimens obtained between 1895–97, and remarks upon an example living in the Pará Museum. Transactions of the Zoological Society of London, 14: 413–420.
- GÖLDI, E.A. (1898b). Further notes on the Amazonian *Lepidosiren*. Proceedings of the Zoological Society of London for the Year 1898: 852–857.
- GÖLDI, E.A. (1898c). A Lenda Amazônica do «Cauré»; considerada à luz da sciencia, e considerações comparativas sobre o ninho da *Panyptila cayanensis* Cab. e de outros Cypselideos (Andorinhões). Boletim do Museu Paraense de História Natural e Ethnographia, 2: 430–442.
- GÖLDI, E.A. (1898d). O estado actual dos conhecimentos sobre os índios do Brasil, especialmente sobre os índios da foz do Amazonas no passado e no presente. Boletim do Museu Paraense de História Natural e Ethnographia, 2: 397–417.
- GÖLDI, E.A. (1899a). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espirito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. Supplement (Herbst 1899). Bern, Buchdruckerei Jent.

- GÖLDI, E.A. (1899b). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1900a). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 2tes. Supplement (Frühjahr 1900). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1900b). Excavações archeológicas em 1895. Executadas pelo Museu Paraense no Littoral da Guyana Brasileira entre Oyapock e Amazonas. 1a. Parte: As cavernas funerárias artificiaes dos Índios hoje extinctos no Rio Cunany (Goanany) e sua cerâmica. Belém, Museu Paraense de História Natural e Ethnographia.
- GÖLDI, E.A. (1901a). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 4tes. Supplement (October 1901). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1901b). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 3tes. Supplement (Januar 1901). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1901c). A piraiba: gigantesco siluroideo do Amazonas. Boletim do Museu Paraense de História Natural e Ethnographia, 3: 181–194.
- GÖLDI, E.A. (1902a). Against the destruction of white Herons and Red Ibises on the Lower Amazon; especially on the Island of Marajó. English translation by Wm. H. Clifford. Belém, Museu Goeldi.
- GÖLDI, E.A. (1902b). Os Mosquitos no Pará, encarados como uma calamidade pública. Belém, Diário Official.
- GÖLDI, E.A. (1902c). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 6tes. Supplement (September 1902). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1902d). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 5tes. Supplement (Juli 1902). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1902–1903). Os mosquitos no Pará encarados como uma calamidade pública. Brazil-Médico, 16: 480–482, 22 Dec. 1902; 17: 5–8, 1st Jan. 1903; 17: 14–19, 8 Jan. 1903; 17: 25–28, 15 Jan. 1903; 17: 35–38, 22 Jan. 1903; 17: 43–45, 1st Feb. 1903.
- GÖLDI, E.A. (1903). Ornithological results of an Expedition up the Capim River, State of Pará, with critical remarks on the Cracidae of Lower Amazonia. The Ibis, ser. VIII, 3: 472–500.
- GÖLDI, E.A. (1904a). Verzeichnis der bisher wissenschaftlich beschriebenen Neuen Tier- und Pflanzenformen welche während der Jahre 1884–1899 in Brasilien (Staaten Rio de Janeiro, Minas Gerais, São Paulo, Espírito Santo, Bahia und Pará) gesammelt und entdeckt worden sind. 7tes. Supplement (Februar 1904). Bern, Buchdruckerei Jent.
- GÖLDI, E.A. (1904b). Os Mosquitos no Pará; resumo provisório dos resultados da campanha de experiências executadas em 1903, especialmente em relação às espécies *Stegomyia fasciata* e *Culex fatigans* sob o ponto de vista sanitário. 2ª Contribuição. Boletim do Museu Goeldi (Museu Paraense) de Historia Natural e Ethnographia, 4: 129–197.
- GÖLDI, E.A. (1905a). Gegen die Vernichtung der weissen Reiher und roten Ibisse auf dem untern Amazonenstrom, besonders auf der Insel Marajó. Nerthus, 1(3), 15 Feb.
- GÖLDI, E.A. (1905b). On *Myiopatis semifusca*, a small Neotropical Tyrantbird, harmful to Treeculture as a Disseminator of the parasitic Loranthaceae. The Ibis, ser. 8th, 5: 169–179.

- GÖLDI, E.A. (1905c). Os Mosquitos do Pará; reunião de quatro trabalhos sobre os mosquitos indígenas, principalmente as especies que molestam o homem. Belém, Museu Goeldi.
- GÖLDI, E.A. (1905d). *Stegomyia fasciata*, der das Gelbfieber übertragende Mosquito und der gegenwärtige Stand der Kenntnisse über die Ursache dieser Krankheit. In: Comptes-Rendus des Séances du Sixième Congrès International de Zoologie tenu à Berne du 14 au 19 Aout 1904. Geneva, Imprimerie W. Kündig & Fils: 193–203.
- GÖLDI, E.A. (1906a). Altindianische Begräbnisurnen und merkwürdig Ton- und Steinidole aus der Amazonas-Region. In: Internationaler Amerikanisten-Kongress, Vierzehnte Tagung, Stuttgart 1904. Berlin, W. Kohlhammer: v. II, 445–453.
- GÖLDI, E.A. (1906b). Über den Gebrauch der Steinaxt bei jetzt lebenden Indianern Südamerikas, speziell Amazoniens. In: Internationaler Amerikanisten-Kongress, Vierzehnte Tagung, Stuttgart 1904. Berlin, W. Kohlhammer: v. II, 441–444.
- GÖLDI, E.A. (1906c). Álbum de Aves Amazônicas. Fascículo 3. Belém, Museu Paraense de História Natural e Ethnographia.
- GÖLDI, E.A. (1912a). Aus der Heimat des Kautschuk und des Parágummi. Der Bund, 16 Apr.
- GÖLDI, E.A. (1912b). Zur vergleichenden Morphologie der Mundgliedmassen bei Crustaceen und Insekten. Zoologischer Anzeiger, Leipzig, 39: 482–487.
- GÖLDI, E.A. (1913a). Die sanitär-pathologische Bedeutung der Insekten und verwandten Gliedertiere, namentlich als Krankheits-Erreger und Krankheits-Überträger. Berlin, R. Friedländer & Sohn.
- GÖLDI, E.A. (1913b). Über ein interessantes, neues Hirsch-Geweih aus Süd-Amerika und über die geographische Verbreitung der Familie der Hirsche (Cerviden) in Süd-Amerika im Allgemeinen. Mitteilungen der Naturforschenden Gesellschaft in Bern aus dem Jahre 1912: 284–300.
- GÖLDI, E.A. (1913c). Die bisherige Anschauung bezüglich der Homologie der Insekten-Mundteile mit den Derivaten des Spaltfusses der Crustaceen und eine notwendig gewordene Modifikation. Mitteilungen der Schweizerischen Entomologischen Gesellschaft, Bern, 12, 4: 146–151.
- GÖLDI, E.A. (1914a). Fort mit der Reiherfeder vom Damenhut! Ein Appell an die Frauenwelt gelegentlich der Schweiz. Landesausstellung. Der Bund, Juni.
- GÖLDI, E.A. (1914b). Die Tierwelt der Schweiz in der Gegenwart und in der Vergangenheit. V. I, Wirbeltiere. Bern, A. Francke.
- GÖLDI, E.A. (1914c). Insekten und Gliedertiere als Krankheitsursache. Hyg. Monatschrift zur Verbreitung des Wissens vom menschlichen Körper, 1, 15 Jan.; 2, 15 Feb.
- GÖLDI, E.A. (1918). Darmkanal und Rüssel der Stubenfliege vom sanitär Standpunkt aus. Mitteilungen der Schweizerischen Entomologischen Gesellschaft, 12: 1–14.
- GRIMALDI, D. & ENGEL, M.S. (2005). Evolution of the Insects. Cambridge (MA), Cambridge University Press.
- GUALTIERI, R.C.E. (2008). Evolucionismo no Brasil: Ciência e Educação nos Museus (1870–1915). São Paulo, LF Editorial.
- GÜNTERT, M., GROSSENBACHER, K., HUBER, C., AERNI, A. & MORGENTHALER, H.U. (1993). The E. A. Goeldi zoological collection in the Natural History Museum Bern: comments on an inventory. Jahrbuch des Naturhistorischen Museums Bern, 1990–1992, 11: 147–161.
- GÜNTERT, M., STEINHEIMER, F. & GESSNER, S. (2005). The mystery of the Gouldian birds: An ornithological detective story. Zoologische Mededelingen Leiden 79–3 (7): 79–84.
- HAECKEL, E. (1877). Histoire de la création des êtres organisés d'après lois naturelles. 2. Ed. Paris, Reinwald.
- HARRISON, G. (1978). Mosquitoes, Malaria and Man: a history of the hostilities since 1880. New York, E. P. Dutton.
- HESS, A. (1917). Prof. Dr. E. A. Göldi. Der ornithologische Beobachter, 14: 196–198.
- HUBER, C. (2008). Die Ringe des Apollo. 150 Jahre Entomologischer Verein Bern 1858–2008. Entomologischer Verein Bern und Naturhistorisches Museum der Burgergemeinde Bern. Bern, Stämpfli AG.
- HUBER, J. (1900). Arboretum Amazonicum. Iconographia dos mais importantes vegetaes espontaneos e cultivados da região amazonica. 2ª. Decada. Belém, Museu Paraense de Historia Natural e Ethnographia.

- HUBER, J. (1906). Arboretum Amazonicum. Iconographia dos mais importantes vegetaes espontaneos e cultivados da região amazonica. 4ª. Decada. Belém, Museu Paraense de Historia Natural e Ethnographia.
- LAENG, R.H. (1973). Geschichte der Säugetierforschung in Bern. Mitteilungen der Naturforschenden Gesellschaft in Bern, 30: 27–29.
- LOPES, M.M. (1997). O Brasil descobre a pesquisa científica. Os museus e as Ciências Naturais no século XIX. São Paulo, Hucitec.
- MARCELIANO, M.L.V. (1996). Estudo osteológico e miológico do crânio de *Opisthocomus hoazin* (Müller, 1776) (Aves: Opisthocomidae), comparado com algumas espécies de Cracidae, Musophagidae e Cuculidae. Boletim do Museu Paraense Emílio Goeldi, série Zoologia, 12, 2: 95–246.
- MATTINGLY, P.F. (1969). The Biology of Mosquito-Borne Disease. London, George Allen and Unwin Ltd.
- McCORMICK, J. (1991). Reclaiming Paradise: the global environmental movement. Bloomington, Indiana University Press.
- MORGENTHAUER, H.U. (1993). Emil August Göldi als Forscher und Lehrer in Bern, 1907–1917. Jahrbuch des Naturhistorischen Museums Bern, 1990–1992, 11: 185–195.
- NYE, M.J. (2006). Scientific biography: history of science by another means? *Isis*, 97: 322–329.
- NYHART, L.K. (1996). Natural history and the «new» biology. In: JARDINE, N.; SECORD, J.A.; SPARY, E.C. (Eds.). *Cultures of natural history*. Cambridge, Cambridge University Press: 426–443.
- NYHART, L.K. (1998). Civic and economic zoology in Nineteenth-Century Germany. *Isis*, 89: 605–630.
- OBRECHT, E. & HUBER, C. (1993). Ducke type specimens and other Brazilian insect types in the Emil A. Goeldi collection in the Natural History Museum Bern (Switzerland). An annotated catalogue. *Jahrbuch des Naturhistorischen Museum Bern*, 11: 163–184.
- PORTER, T.M. (2006). Is the life of the scientist a scientific unit? *Isis*, 97: 314–321.
- ROSENBERG, C.E. (1988). Woods or trees? Ideas and actors in the History of Science. *Isis*, 79: 565–570.
- ROUBIK, D.W. (1992). *Ecology and Natural History of Tropical Bees*. Cambridge, Cambridge University Press.
- SANJAD, N. (2003). Da abominável profissão de vampiros: Emílio Goeldi e «Os Mosquitos no Pará» (1905). *História, Ciências, Saúde-Manguinhos*, 10: 85–111.
- SANJAD, N. (2009). *Emílio Goeldi (1859–1917). A ventura de um naturalista entre a Europa e o Brasil*. Rio de Janeiro, EMC Edições.
- SANJAD, N. (2010a). *História natural e medicina na obra de Adolpho Lutz (1855–1940)*. *História, Ciências, Saúde-Manguinhos*, 17: 215–218.
- SANJAD, N. (2010b). *A Coruja de Minerva: o Museu Paraense entre o Império e a República, 1866–1907*. Brasília, Instituto Brasileiro de Museus; Belém, Museu Paraense Emílio Goeldi; Rio de Janeiro, Fundação Oswaldo Cruz.
- SCHÄR, L. (1892). *Reise und Abenteuer eines Schweizer-Colonisten in Brasilien*. Arbon, Druck und Verlag von G. Rüdlinger.
- SNETHLAGE, Emilie (1914). *Catálogo de Aves Amazônicas*. Boletim do Museu Paraense de História Natural e Ethnographia, 8: 1–530.
- SODRÉ, L. (1894). *Mensagem dirigida pelo Sr. Governador Dr. Lauro Sodré ao Congresso do Estado do Pará em 7 de abril de 1894*. Belém, Typ. do Diário Official.
- TRATADO de Arbitramento concluído no Rio de Janeiro aos 10 de abril de 1897 entre a República dos Estados Unidos do Brasil e a República Francesa (1897). Paris, Imprimerie Lahure.
- WANNER, Alex (Ed.) (2001). *Augen-Blicke. 150 Jahre Kantonsschule Schaffhausen*. Schaffhausen, Kantonsschule Schaffhausen.
- WINSTON, M. (1987). *The Biology of the Honey Bee*. Cambridge (MA), Harvard University Press.