Documentation of Terminologia NeuroAnatomica

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1.1 The initial steps of TNA

In 2012, the President of the International Federation of Associations of Anatomists (IFAA), Bernard Moxham, initiated a new Working Group on Neuroanatomy for the Federative Programme for Anatomical Terminology (FIPAT). In the beginning, this Working Group was composed of Hans J. ten Donkelaar (The Netherlands) as coordinator and Jonas Broman (Sweden), Luis Puelles (Spain) and Alessandro Riva (Italy) as advisors. At the first FIPAT Meeting (Beijing, August 7, 2014), Shane Tubbs (USA) and Paul Neumann (Canada) were added, suggested by Stephen Carmichael and Pierre Sprumont, respectively. Later, Marco Catani (UK) and David Kachlik (Czech Republic) were included as well.

A first step was the implementation of a more natural hierarchical and embryologically-based classification of brain structures for the prosencephalon (forebrain), following the prosomeric model instead of Herrick's columnar model (Puelles 2013). Neuron types were implemented for all of the sections as well as the blood vessels of the brain and spinal cord. After discussions in Beijing, the prosomeric approach was also applied in the second edition of the Terminologia Embryologica (TE2). Proposals for a new Terminologia Neuroanatomica (TNA) were presented and extensively discussed at the FIPAT Meetings in Istanbul (August 31/September 1, 2015) and Göttingen (September 24, 2016). At the Göttingen Meeting, the IFAA Exco endorsed the TNA as well as the TE2 as validated to be posted on the FIPAT websites. Early 2017, the TE2 and TNA were published at FIPAT's Dalhousie website. To promote the TNA, an introductory paper was published in Clinical Anatomy (ten Donkelaar et al. 2017).

1.2 The development of TNA

The TNA is a recent revision of the terminology on the Central Nervous System (CNS; Systema nervosum centrale), the Peripheral Nervous System (PNS; Systema nervosum periphericum) and the Sense Organs (Organa sensuum). These were abstracted from the Terminologia Anatomica (1998) and the Terminologia Histologica (2008) and were extensively updated by the FIPAT Working Group Neuroanatomy, and merged to form a Terminologia Neuroanatomica (TNA), representing about 40 % of the Terminologia Anatomica. Because of its clinical and functional significance, the TNA includes the blood supply to the CNS (Vasa sanguinea encephali and Vasa sanguinea medullae spinalis) to ensure it contains a more or less complete list of terms for the human nervous system.

The document is divided into three chapters, see their description below. The official FIPAT terms are in Latin. This enables translation into any vernacular, in the present instance English. The Latin terms have been reviewed by members of the FIPAT Latin Subcommittee. See thereafter the documentation on universal model and translations in the different vernacular.

Chapter 1 : The Central Nervous System

1. Throughout the document, the subdivision of neurons proposed by Bota and Swanson (2007) is used, following the Brain Architecture Manage-

ment System (BAMS; http://brancusi.usc.edu/bkms) , and including sensory neurons, interneurons (with short or long axons) and motoneurons. The short interneurons are subdivided into excitatory and inhibitory interneurons. The category interneurons with a long axon comprises those interneurons that are usually described as projection, commissural and association neurons.

2. For the white matter tracts, the Foundation Model of Connectivity (Swanson and Bota 2010) is followed for a better presentation. The following subdivision is used: (a) Central roots (radices centrales) for the cranial and spinal nerve roots within the CNS; (b) intrinsic tracts (tractus proprii) remaining within a certain compartment of the CNS such as the spinal cord or the telencephalon; (c) commissural connections (tractus commissurales); and (d) longitudinal tracts (tractus longi) divided into ascending tracts, descending tracts and efferent tracts of the cerebellum.

3. A new section blood vessels is added, a modernized version of the relevant part of the TA Section Systema cardiovasculare. Clinically relevant subdivisions of the arteria carotis interna (C1-C7), arteria cerebri anterior (A1-A5), arteria cerebri media (M1-M4), arteria vertebralis (V1-V4) and arteria cerebri posterior (P1-P4) are added.

4. For the spinal cord, the order of presentation is changed from posterior (dorsal) to anterior (ventral) to be consistent with the presentation of the Rexed layers from I-X, and for consistency with other sections. The known neuron types are added and the white matter is subdivided into central roots, propriospinal tracts and long tracts, ascending and descending.

5. For the brain stem, the various nuclei are rearranged according to their connectivity, following the third edition of Olszewski and Baxter (Büttner-Ennever and Horn 2014): somatosensory nuclei, viscerosensory nuclei, vestibular nuclei, acustic nuclei, somatomotor nuclei, branchiomotor nuclei, visceromotor nuclei, reticular nuclei, neuromodulatory nuclei (serotonergic, adrenergic, noradrenergic, cholinergic and dopaminergic cell groups), limbic nuclei and precerebellar nuclei. The white matter is subdivided into central roots, intrinsic tracts and long tracts, ascending, descending and cerebellar efferent.

6. For the mesencephalon, the following subdivision is used: pedunculus cerebri (the long corticofugal fibres), tegmentum mesencephali (including the substantia nigra and the ventral tegmental area), substantiae centrales mesencephali and tectum mesencephali.

7. For the cerebellum, the terminology of the lobuli was simplified, the zonal, sagittal organization of corticonuclear projections is introduced and the composition of the cerebellar peduncles is added.

8. A more natural hierarchical classification of brain structures is used for the forebrain (prosencephalon) as implemented in the revised version of the Terminologia Embryologica (TE2). The forebrain is subdivided into the caudal prosencephalon, giving rise to the diencephalon, and a rostral or secondary prosencephalon, giving rise to the hypothalamus and the entire

telencephalon. The telencephalon is divided into the pallium and the subpallium (striatum, pallidum, basal forebrain and preoptic area). For practical reasons, the preoptic area is listed following the hypothalamus.

9. The diencephalon in its classic, columnar view was divided into four dorsoventrally arranged columns separated by ventricular sulci: the epithalamus, the dorsal thalamus, the ventral thalamus and the hypothalamus. Extensive embryological studies made it clear that the thalamic 'columns' are derived from transversely oriented zones, the prosomeres (Puelles 2013; TE2). Currently, the diencephalon is subdivided into three segmental units, which from caudal to rostral, contain in their alar domains the pretectum (prosomere 1 or P1), the epithalamus and thalamus (P2) and the ventral thalamus or prethalamus (P3). The diencephalic basal plate (P1-P3) contains the rostral part of the substantia nigra - VTA complex and the interstitial nucleus (nucleus of Cajal), the rostral interstitial nucleus of the medial longitudinal fasciculus, and the elliptic nucleus (nucleus of Darkschewitsch), collectively forming the diencephalic or prerubral tegmentum between the midbrain and the hypothalamus. The entire hypothalamus arises from the alar and basal components of the secondary prosencephalon. The preoptic area is one of the subpallial developmental domains.

10. For the thalamic nuclei, a new subdivision based on Hirai and Jones (1989) and updated by Morel et al. (1997) is introduced. The description of the external features (morphologia externa) of the cerebral hemisphere is extended, including many newly discovered or rediscovered subdivisions. Macroscopically visible olfactory structures are included here. A more extensive discussion of the allocortex is provided.

11. The description of the internal features (morphologia interna) of the cerebral cortex follows the embryological subdivision of the pallium into four parts. The dorsal pallium gives rise to the isocortex or neocortex, the lateral pallium to the claustro-insular complex, the medial pallium to the hippocampal formation and the ventral pallium to the olfactory cortex and the pallial amygdala. Where possible, neuron types are added, starting from the TH terminology. Isocortical neurons are subdivided into pyramidal neurons (projection, commissural and association neurons) and excitatory and inhibitory interneurons. For the inhibitory, mainly GABAergic, interneurons, the Petilla terminology (DeFelipe et al. 2013) is introduced.

12. Under the heading subpallium, the amygdaloid body or complex, the basal forebrain and the basal nuclei (or ganglia) are listed with neuron types and fibre connections.

Chapter 2 : The Peripheral Nervous System

1. All communicating branches that are readily apparent and all those known to have functional significance are included. Any communicating branches that are difficult to demonstrate or have no known function are deleted. The communicating branches are listed as branches of the nerve at their central (proximal) end. Their naming is simplified, eliminating prepositions (ad and cum). To the sympathetic, thoracolumbar part of the

autonomic division two additional subsections are added to include other parts of the autonomic division that contain sympathetic neurons and postganglionic sympathetic fibres: (a) the paravertebral ganglia of thorax and abdomen; and (b) perivascular plexuses and their branches that contain postganglionic fibres.

2. The parasympathetic or craniosacral part of the autonomic division includes three subdivisions that contain parasympathetic ganglia and nerve branches that contain parasympathetic fibres to visceral organs: (a) cranial parasympathetic ganglia and their branches; (b) the two vagus trunks and their branches; and (c) the pelvic splanchnic nerves. The pelvic ganglia are replaced under visceral plexuses because they are not classic parasympathetic ganglia.

3. The visceral plexuses include those containing sympathetic and parasympathetic fibres and small ganglia associated with these plexuses. These ganglia were formerly considered parasympathetic ganglia, but have been shown to contain also many neurons that are not classically sympathetic or parasympathetic.

4. The enteric plexus is treated separately because this intramural plexus of the digestive canal is usually considered a nervous system separate from the autonomic or peripheral nervous system: the enteric nervous system (systema nervosum entericum).

Chapter 3 : The Sense Organs

An attempt is made to merge TA and TH terms on the sense organs (organa sensuum). Several clinical experts were involved in this process, including ENT surgeons (Matthew Carlson, Mayo Clinic; and later Vedat Topsakal, Brussels, Belgium, and Brandon Isaacson, Dallas, USA) and a neuroophthalmologist (Hans Cruysberg (Nijmegen, The Netherlands). Major changes include a restructuring of the layers of the eye and the classification of sensory neurons.

Acceptance at the 19th IFAA World Congress 2019

The TNA as published on FIPAT's Dalhousie website (http://FIPAT.library.dal.ca) was accepted August 9, 2019 at the 19th IFAA World Congress in London (UK) as the official terminology for the nervous system and the sense organs. Also a Symposium on the TNA was held at the 19th IFAA Meeting.

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1.3 Further developments of TNA

To promote the TNA, an illustrated version, entitled An Illustrated Terminologia Neuroanatomica: A Concise Encyclopedia of Human Neuroanatomy (ten Donkelaar, Kachlik and Tubbs) was published 2018 (Springer, Cham) with contributions from among others, many FIPAT colleagues. To enhance the TNA, a research topic Recent Developments in Neuroanatomical Terminology for Frontiers in Neuroanatomy was started by Hans J. ten Donkelaar and Luis Puelles. During 2018 and 2019, 12 papers, one commentary and an editorial were published on four topics:

- further development of a developmental ontology (Puelles 2019; Watson et al. 2019);

- common terminology for the cerebral cortex (ten Donkelaar et al. 2018) and the thalamus (Mai and Majtanik 2019);

- white matter tracts, including a new scheme for the presentation of white matter tracts (Baud et al. 2018) and a new approach to the long association tracts (Mandonnet et al. 2018);

◦ neuron types, including a new approach to cortical neuron names (Shepherd et al. 2019) and one on auditory nomenclature (Fritzsch and Elliott 2018).

Many of these new data were used to improve the TNA as discussed in the next item. Combining TNA and the Fritzsch/Elliott paper, an updated terminology for the internal and middle ear with combined anatomical and clinical terms was published (ten Donkelaar et al. 2020), (Topsakal et al. 2021). Recently, an overview of the TNA was published in Plexus (ten Donkelaar et Baud, 2021)

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1.4 The digitalization of TNA

Computerization of the TNA is a necessary task due to the size and complexity of the data. Manual handling is not appropriate today. Our goal is to be compatible with the essentials of database development in life sciences as recommended by the OBO Foundry (Smith et al. 2007). The database implementation of the TNA is prepared in a well defined context. In short, the following guiding lines are to be mentioned:

- There is a need to access a taxonomy of the domain; to do that, we naturally have selected the taxonomy of the Foundation Model of Anatomy (FMA) as developed by Rosse and Mejino, 2003;
- In order to be compatible with other ontologies in related domains, we have adopted the basic principles of Basic Formal Ontology (BFO 2.0; Smith et al. 2015);
- Since the TNA derives from the TA98, and cross references are present, the TA database is an integral part of the TNA database;
- A preponderant goal of FIPAT is the translation into numerous languages, giving an international dimension to the whole terminology; manual translation is dependent on unavailable humanpower resources and must be replaced by an adequate automatic translation; this is a necessary solution for a terminology subject to permanent updates and improvements.
- The identifiers of TA98, as officially adopted by FIPAT in 2013 (see Fribourg website), are preserved; each new term receives a new unique, computer-generated identifier;
- In the partonomic lists, external references are given to the FMA and the TA98, whereever they are possible;
- For further information, see Baud and ten Donkelaar (2019).

During the preparation of the TNA database, the following major changes were developed:

1. presenting the terms in a top-down approach, i.e from telencephalon to spinal cord, to make terms compatible to the FMA and other parts of the TA98;
2. the new view on tracts presented by Baud et al. (2018) was implemented;

3. a universal model for terms was applied; the basic part of a term and its expansions to already existing related terms, starting from the Latin representation, are modeled giving the universal formula independent of any language.

The universal model of the terminology is a process that produces a universal representation independent of any language. The translation process is successful because the languages of anatomical terminology are a subset (without verbs) of the natural languages. In such a context, an exact translation can be reached but human validation is recommended for some terms.

The white matter of the CNS is difficult to represent in anatomy because it is located predominantly 'between' other anatomical entities. In a classic presentation, like a cross section of a brain segment, white matter is present and can be labelled adequately. Several appearances of the same entity are feasible on distant presentations. The problem is the absence of a global view on long tracts, and more generally, the lack of a comprehensive classification of white matter pathways. From the Terminologia Neuroanatomica (TNA 2017), Baud et al. (2018) have developed a new schema for the representation of white matter. In this approach, white matter is directly attached to the CNS, and no more considered as part of the brain segments. Such a move does not affect the content but redistributes the anatomical entities in a more natural fashion. The new classification of white matter tracts selects the origin as the primary criterion and the type of tract as the secondary criterion. On this basis, the tracts of the CNS were classified by their origin in the following nine segments: telencephalon (pallium), telencephalon (subpallium), hypothalamus, diencephalon, mesencephalon, cerebellum, rhombencephalon rostrale, rhombencephalon caudale and medulla spinalis. For the type of tracts, the criteria of the TNA are followed: central roots, commissural tracts, intrinsic tracts and long tracts.

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1.5 Partonomic lists

Anatomists at large prefers the presentation of anatomical entities under the guidance of the *part of* relation: a selected entity one want to document is selected as well as all its composing parts. This schema is derived from the concept of the atlas of anatomy with multiple figures illustrating the human body. This is quite a natural approach. But it is formally complicated and easily subject to errors and ambiguities. This section will illustrate the formal aspects of the partonomy.

Consider at first the Terminologia Anatomica, version 1998. It is essentially presented as partonomy lists. But it has a few sections call *Nomina generalia* that are definitely not a partonomy, but belongs to the taxonomy. In addition, a few taxonomic links are present by accident. There is also the presence of *contained in* relations, that cannot be assimilated to a *part of* relations. Finally, TA98 presents a few hundreds of cross references from one section to another, repeating an entity where a pertinent relation to the local context is an evidence; but such an interspersed entity is not in a *part of* relation in the actual context; this is hardly visible, only by the broken sequence of identifiers.

The *part of* relation must be precisely defined for the domain of anatomy. This relation must be specialized in order to account for numerous situation. The following cases have to be defined:

- what is a material sub part, using the developmental concepts of embryology; exclude the contained in relation;
- how an immaterial entity is a part of a material entity;
- what is an immaterial sub part of an immaterial entity;
- what is a composite entity, and what are its parts with which relations;
- what is a mixed composite entity and how it articulates with other entities.

For the new terminology, a taxonomy of *part of* relations has been designed under the form of *non physical* entities. Any anatomical entity being situated somewhere in the partonomy, it must necessarily have a *part of* relation to its partonomic ancestor. Such a relation must be explicitly documented. Of course, a casual user of the terminology may not be interested by this formal aspect, but if for any reason there is a need to clarify the situation, the information is available.

There is an undefined number of partonomies in the domain of anatomy. Each partonomy is usually defined by its top entity. One particular entity is named the global partonomy and has as its top entity *corpus humanum*. Other partial partonomies are necessary when we encounter a composite entity like *rod cells*; it is desirable to examine the partonomy of a single anonym *rod cell*, what can be done by opening a partial partonomy, marked by the number sign, giving # *rod cell* and followed by the indented partonomic hierarchy. A partial partonomy is not a part of the global partonomy: it is distinct and if it is presented there, it's only a presentation convenience.

The option of mentioning any entity position elsewhere outside of the actual section of the partonomy is clearly a didactic advantage. The true meaning of such a reference is "see also" and nothing more. The user is warned not to over interpret such a relation. For example, the *sinus venosus sclerae* is not *part of* the *sclera*, but a part of the *systema cardiovasculare*; however, it is appropriate to mention it in the partonomy of the *sclera*. In the terminology, such a situation is marked with an eye icon.

1.6 White matter representation

The white matter of the Central Nervous System is difficult to represent. The first reason is that it represents an extremely complex network of connections, of which we have a limited knowledge. The second reason is that the reality contradicts our current vision of anatomy: if the axons making the white matter are considered as part of their neural cell - what they are in reality - we have a part of the telencephalon in the spinal cord! For this reason, it has been considered as advantageous to consider the white matter as an independant constituting part of the CNS, whatever their original source cells.

In this new schema, described by a recent publication (see Baud et all, 2019), the connections of the white matter are classified by:

1. their origin,
2. their type,
3. other attributes.

When considering any single segment of the CNS, references are given to the white matter components of interest there. A component visible in different segments could be referenced several times.

1.7 A universal model

A terminology must be independant of any language, or, differently said, it must be valid for all languages without bias favoring some specific source language. Considering a terminology like Terminologia Anatomica, which is definitely a large-size terminology, such an independance is a real challenge: anatomy is universal and everybody agrees. However, we must concede that such a goal is rarely reached. A few languages have the lead, principally English which support the vast majority of the scientific literature.

In order to reach this major goal, a Universal representation of terms has been designed. The source representation of anatomical term is neither English, Latin or any other language, but it is replaced by a universal formula referring to an abstract vocabulary and providing relations between these components. The universal formulas are governed by a formal grammar documented elsewhere. As a result, a majority of anatomical terms can be represented by such a formula and a marginal part of them can be accomodated as exceptions, in order to reflect the cultural heritage and the tradition involved with the natural languages.

A recent discussion within FIPAT is about the RAT terms (Regular Anatomical Terms). Several rules have been proposed and the pros and cons have been presented. However, different opinions would be hard to reconciliate and presently, if some points would find a clear majority, other points (rules 10 to 12) are far from a safe decision. By safe we mean a solution that does not induce a clivage in the community of anatomists.

As a summary of the present situation, we argue that the new TNA with automatic term generation in 5 languages brings new arguments to the discussion. It is also recommended that more factual arguments be presented.

It has been demonstrated by the actual implementation that most languages easily fit to the universal representation with an acceptance rate above 95 %. More versatile languages would anyway present an acceptance rate above 90 %.

It becomes immediately visible that this situation save a considerable amount of manpower for the design and maintenance of the terminology. A terminology of 50000 terms in 5 languages with an acceptance rate of 95 % will save 72 % of the work. And this calculation is very conservative.

In addition to this quantitative estimation, a qualitative benefit as been found. The reason is that terminology is difficult in any language and that the discovery of the good terms is not error prone and is facing multiple obstacles. The overall coherence of the terminology is difficult to reach and it is necessary to set a number of informal rules governing the usage of any language. As a general statement, one cannot escape this difficulty, but the universal formulas are able to guarranty a significant part of the whole.

The universal model of the terminology is progressively documented elsewhere.

In the future implementations of the TNA, the universal formulas will be made visible and the acceptance rate of any specific language will be documented.

The authors of the terminology expect from the universal model a tripple advantage: 1) saving resources without impacting the quality; 2) preserving when necessary the idiomatic facets of the natural languages; 3) enforcing the equivalency between languages.

1.8 The terminology in five languages

The actual version of the terminology is presented in 5 languages: Latin, English, French, Spanish and Russian. A rather strict discipline is followed in order to translate the terms in all languages in the respect of the source universal terms. However, it is well known that languages are versatile and largely dependent on culture and traditions in different countries: a fully rational or formal point of view is not adequate. The authors of the terminology must always balance between the scientific desiderata leading to precise and unambiguous terms and the irrational roots of the human languages: here is the beauty and the difficulty of this enterprise.

The most global goal of a terminology is certainly to contribute to a precise and non ambiguous communication between scientists of the world. It would be an error to consider that good communication in a single language is sufficient, even if this language is English known to support the majority of the scientific literature. Communication implies a sender and a receiver. If the sender is in position to master the English language or is getting adequate help from native speakers, this is not true for the receivers. Medicine is thought in more than 50 languages all over the world: any actor would benefit from a multilingual distribution of the anatomical terminology.

Terminologia Anatomica was originally published in 1998 in Latin with English equivalent terms (TA98). In the years later, translations in Spanish, Russian and Japanese (possibly other versions) were made available by national initiatives. But these efforts were not coordinated, but in the absence of revisions of the terminology, this was not problem. Today, we foresee that the new versions of the terminology will be permanently updated. Therefore, the need of a coordinated development in several languages is indicated. Automatic translation is no more an option, but the condition for any future terminology of the size of TA

To promote the translation of the TNA into multiple languages, translation by computer program into French, Spanish and Russian has been designed and realized by Robert Baud, in addition to the translation from the universal representation in Latin and in English. A validation by a team of enthusiastic anatomists and neuroscientists, including Odile Plaisant, Alexis Guédon, Nathalie Tzourio-Mazoyer and Laurent Petit for French, Ricardo Insausti (with Luis Puelles and Javier DeFelipe) for Spanish and Yuriy Vasiliev (with Sergey Dydykin) for Russian. Versions coupling Latin with a modern language are available, like LA-EN, LA-FR, LA-ES, LA-RU, as well a five-language version to facilitate comparisons.

It should be noted that in 2020 a Polish version of the TNA was published online. Italian and Portuguese translations are in preparation and possibly in other languages as well. Asian languages would need cooperation with native-speaking experts.

What is the cost of adding a new language? This is a double operation: 1) a specific interface must be programmed, taking advantage of a similar language; 2) a vocabulary of some 3000 words must be translated for that language. One man-month of a skilled computer person is necessary. Another man-month effort by a native speaker expert in anatomy is needed for validation. All the work can be coordinated on the internet.

The authors of the terminology are convinced that a new space of communication in anatomy is now open. The multilingual approach is its visible aspect.

1.9 Implementation

The digitized version of the TNA includes the following sections:

Chapter 1: CNS

- Meninges
- Systema arteriosum cerebrospinale (Cerebrospinal arterial system)
- Systema venosum cerebrospinale (Cerebrospinal venous system)
- Systema ventriculare (Ventricular system)
- Telencephalon
- Hypothalamus
- Diencephalon
- Mesencephalon
- Cerebellum
- Rhombencephalon rostrale (Rostral rhombencephalon; rostral hindbrain)

- Pons, the pars basilaris rhombencephali rostralis
- Rhombencephalon caudale (Caudal rhombencephalon; caudal hindbrain)
- Medulla spinalis
- Tractus systematis nervosi centralis (Tracts of central nervous system)

Chapter 2: PNS

- Divisio nervorum cranialium (Cranial nerves)
- Divisio nervorum spinalium (Spinal nerves)
- Plexus nervi somatici (Plexuses of somatic nerves; plexuses of spinal nerves)
- Divisio autonomica (Autonomic division)

Chapter 3: Sense organs

- Organum olfactorium (Olfactory organ)
- Organum visuale (Visual organ)
- Organum vestibulocochleare (Vestibulocochlear organ)
- Organum gustatorium (Gustatory organ)

Complement: Cerebral vessels

- Cerebral arteries
- Cerebral veins

Depending on progress, the various sections will be placed on the public part of the IFAA Fribourg website (http://unifr.ch/ifaa), including versions in Latin, English, French, Spanish and Russian, so that Anatomical Societies can comment and, wherever necessary, correct terms. The digitized version will be presented at the next IFAA World Congress (August 2022) in Istanbul (Turkey).

About the banner of the website
The photo of the banner is dated August 2007, taken during a flight from Rangiroa to Nuku Hiva at the Marquises Islands. The blue color is the sea, the plane flying above the clouds.

1.10 Future developments

Further developments are dependent on manpower resources, which availability is uncertain. However, a number of intermediate goals are known and are expected to be fulfilled in the coming years. They are the following:

1. Availability of the TNA under the form of Published lists; this goal is already partially satisfied;

2. Navigation in partonomic lists;
3. Availability of the Unit Pages;
4. Availability of the Entity Pages and the Universal Pages;
5. Navigation in taxonomic lists;
6. Introduction of additional languages;
7. Creation of a search engine on the website;
8. Interactive graphical presentation of TNA;
9. Development of the definitions;
10. Improvement of the didactic aspects of the website;
11. Internal documentation;

The long term goal would be to have a Terminologia Anatomiae Humanae, including a merging of anatomical and histological terms as in the TNA. It would be great if this would be achieved by 2025, 130 years after the first Nomina Anatomica (BNA 1895).